M/035/009

SERGENT, HAUSKINS & BECKWITH

GEOTECHNICAL INVESTIGATION REPORT
WASTE ROCK DUMPS
BARNEYS CANYON PROJECT
SALT LAKE COUNTY, UTAH

Prepared for:

BP Minerals, America
1515 Mineral Square
Salt Lake City, Utah 84112

SHB Job No. E87-2038B

Consulting Geotechnical Engineers

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APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

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January 21, 1988

BP Minerals, America
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SHB Job No. E87-2038B

Attention: Colin Smith

Re: Geotechnical Investigation Report
Waste Rock Dumps
Barneys Canyon Project
Salt Lake County, Utah

Gentlemen:

Transmitted herewith is our Geotechnical Investigation Report for the waste rock dumps for the referenced project. The report presents the results of the field investigation performed in December, 1987 and the results of laboratory analyses, along with our evaluation of the overall stability of the dumps.

If any questions or comments arise concerning this report, please contact the undersigned.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By Darrel L. Buffington
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SHB Job No. E87-2038B

1. INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed waste rock dumps for BP Minerals America's Barneys Canyon Project. The project site is located within the west central portion of Section 31 and the east central portion of Section 36, T2S, R2W, in Salt Lake County, Utah. A site plan showing the overall site layout is presented in Appendix A.

The objective of this investigation was to evaluate the physical properties of the soils and rock underlying the site, to enable an evaluation of the slope stability of the proposed waste rock dumps.

2. PROJECT DETAILS

Approximately 400 million tons of waste rock produced from development of the Barneys Canyon pit is to be disposed of in two dumps as indicated in the site plan presented in Appendix A. The dumps will be constructed by end dumping in essentially a side hill configuration on topography which generally ranges from 13 to 38 percent. Advance of the dumps will be in lifts reaching maximum heights of 280 feet.

8°–21°

3. INVESTIGATION

3.1 Review of Available Data

During the course of the investigation, the following data were acquired and reviewed:

A. Published and unpublished geologic mapping and literature available from governmental agencies, and professional societies.

B. Published groundwater literature from state governmental agencies.

C. Published reports concerning regional seismotectonics and seismic hazards.

D. Previous geotechnical investigation reports prepared by SHB for the UCD Modernization Project.

3.2 Geologic Reconnaissance

As part of the site investigation for the waste rock dumps as well as the associated heap leach pads, a geologic reconnaissance was performed by Bruce N. Kaliser, Senior Geologist with SHB. Of primary interest in the reconnaissance was evaluating the potential for debris flows and the presence of landslide features within the site area. Surface exposures were somewhat limited due to snow cover at the time of the reconnaissance.

3.3 Subsurface Investigation

A total of 12 exploratory borings were completed in the area of the waste dumps. These include Borings B-9, B-10, B-14, B-15, PB-3 and PB-4 drilled for the heap leach pad and reported in the Geotechnical Investigation Report dated January 20, 1988 (SHB Job No. E87-2038B.) The borings were advanced utilizing a CME-55 drill rig equipped with 6-1/2 inch hollow stem auger to depths ranging from 10 to 45 feet below existing site grade.

Standard penetration testing or open end drive sampling were performed at five foot intervals or less in the hollow stem auger borings.

All soils were classified using the Unified Soil Classification System (ASTM D2487) which is summarized in Appendix A. Terminology used in the description of soils and a description of drilling methods employed, are also presented in Appendix A. A site plan showing the location of the borings is presented in Appendix A. The field investigation was supervised by Jim Higbee, P.E. of this firm.

3.4 Laboratory Testing

Moisture contents were determined for selected disturbed samples and are shown on the boring logs. To aid in the classification of subgrade materials, the grain-size distribution and Atterberg Limits of selected samples were determined. Results are presented in Appendix B. As part of the geotechnical investigation for the heap leach pad, direct shear tests were performed on in situ and remolded samples of pad subgrade material to evaluate the engineering properties of materials that will form the leach pad and waste dump foundations. Results of the direct shear testing are presented in Appendix B of the Geotechnical Investigation Report for the heap leach pad (SHB Job No. E87-2038A) and are summarized herein Figure 1.

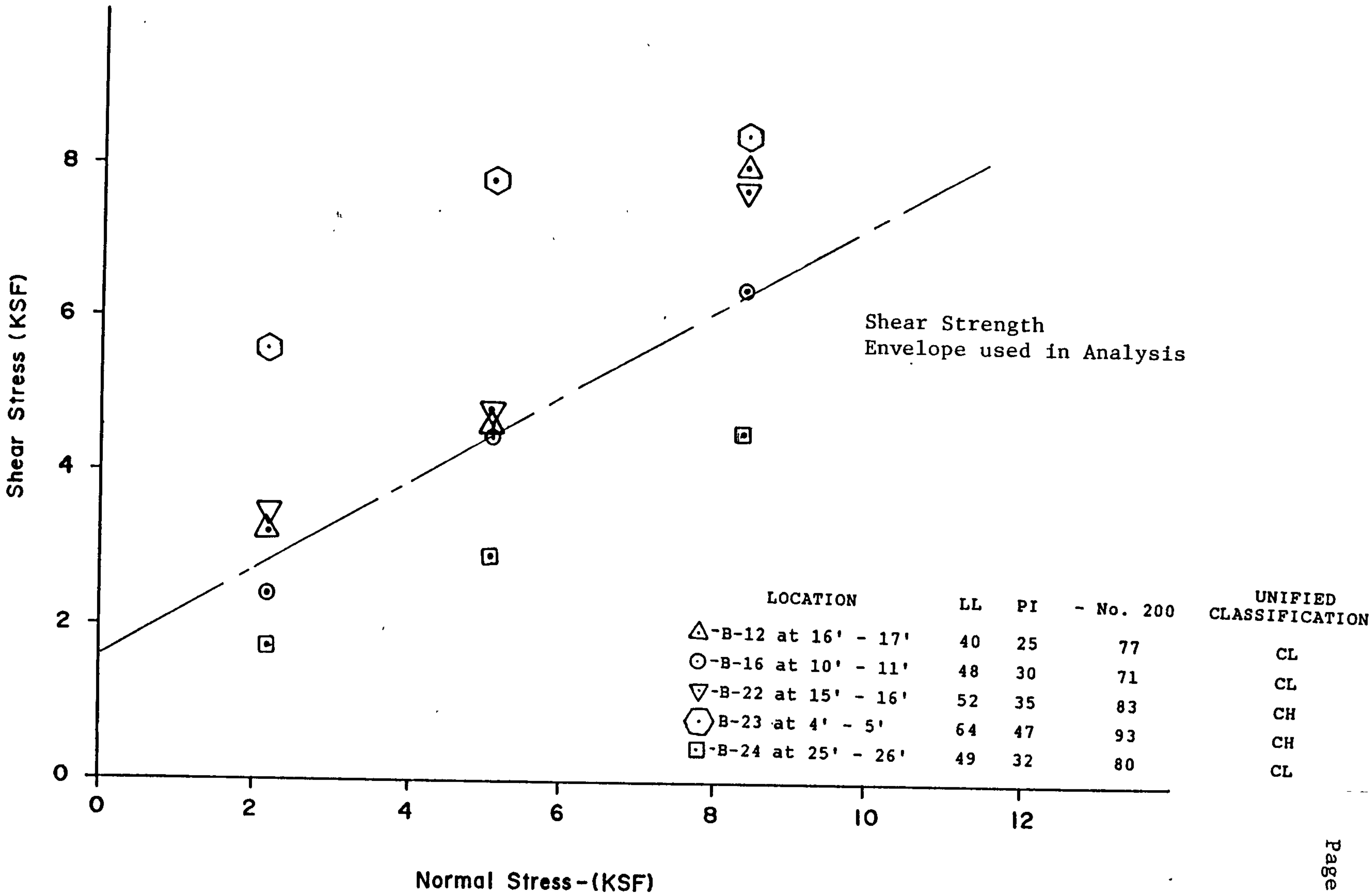
4. GEOLOGY & GEOTECHNICAL PROFILE

4.1 Regional Setting

The Barneys Canyon Project site is located along the eastern flank of the northern portion of the Oquirrh Mountains. The Oquirrh Range is a typical north-south trending, block faulted range in the eastern part of the Basin and Range physiographic province. Bedrock consists of Late Paleozoic and Tertiary Age sedimentary and volcanic units, unconformably overlain by the Early Pleistocene Harkers Alluvium. To the east of the site, the Harkers is in turn overlain by constructional shoreline and lake bottom deposits of Mid-Late Pleistocene Lake Bonneville, and by Late Pleistocene to recent alluvial fan deposits, stream gravels, valley fill and talus deposits (Tooker and Roberts, 1971a and 1971b; Swensen, 1975; Davis, 1983).

The most significant geologic unit relative to the waste rock dump site geology is the Harkers Alluvium, of

FIGURE 1 Summary of Direct Shear Data
Undisturbed Samples



probable early Pleistocene age. Shoreline facies deposits of Lake Bonneville, mapped as the Bonneville Alpine Formation, unconformably overlie the Harkers Alluvium along the Elevation 5200 shoreline of Lake Bonneville, about three miles east of the site. The youngest materials in the site area are relatively thin deposits of recent alluvium along the dissecting drainages.

The Harkers Alluvium was originally named the Harkers Fanglomerate for its type locality in Harkers Canyon by Slentz (1955) and was renamed the Harkers Alluvium by Tooker and Roberts (1971a) because of its great size distribution and largely unindurated nature. It occurs as extensive fan deposits on both sides of the Oquirrh Mountains. The thickness is unknown but probably reaches more than 300 feet in places and probably varies considerably. This unit unconformably overlies Tertiary volcanic rocks along the east flank of the Oquirrh Range, including the site area.

The character of the Harkers Alluvium is highly variable but, in general, consists of poorly sorted boulders, coarse to fine gravel, sand, silt and clay. Natural exposures are not common, but the Harkers is well exposed in numerous railroad cuts, including some along the Tailings pipeline corridor that bounds the east end of the site. Poorly sorted layers contain boulders up to several feet or more in diameter with clayey sands and gravels, clean, well-sorted sands and gravels with well-developed cross bedding, and occasional well sorted layers of silty or sandy clay and clay. Erosion and deposition by successive cross-cutting stream channels is evident in all exposures. Some of the more poorly sorted deposits, containing large boulders in a matrix of gravel, sand, silt and clay, were probably deposited by mudflows. The rapidly changing and cross-cutting nature of the various deposits within the Harkers results in a highly variable and unpredictable nature of the alluvium underlying the site.

Slentz (1955) considered the Harkers to be Pliocene in age, but Tooker and Roberts (1971a) assigned it an early Pleistocene age, largely because of its unconsolidated nature and because it overlies consolidated Tertiary sedimentary and volcanic rocks. No fossil evidence for an age assignment has been found.

4.2 Regional Groundwater Conditions

Hely and others (1971) present a map showing water level contours for the principal aquifer on the eastern side of the Oquirrh Mountains. From Barneys Creek north to Magna, depths to the principal aquifer are extremely generalized, and only one observation well existed at the time of publication of their map. The surface of the principal aquifer is thought to dip steeply downward from the east flank of the Oquirrh Range toward the Jordan Valley.

Based on the groundwater contours literature and recent groundwater level data, (Dames & Moore, 1988) the

principal groundwater aquifer occurs between approximately 100 to 300 feet below the ground surface at the heap leach pads site.

4.3 SITE CONDITIONS

4.3.1 Local Setting

The waste dump site is located on a broad alluvial fan sloping off the eastern flank of the Oquirrh Range which has been dissected by generally east flowing ephemeral drainages. The ground surface across the site ranges from elevation 6600 feet at the western most edge of the northern dump to about 6000 feet at the eastern edge of the southern dump. Overall ground slope is at about 16 percent to the east. Locally however, slopes as steep as 50 percent occur along the steep sided drainages crossing the site.

On site vegetation consists of sagebrush, sparse grass and scattered thickets of brush and small trees.

4.3.2 Geotechnical Profile

The proposed waste rock dump site is underlain by highly variable units of clay, silt, sand, gravel, cobbles and boulders. The materials are generally stratified, but variations within individual layers are frequent and unpredictable. These deposits are underlain, at depth, in turn, by an irregular bedrock surface.

The alluvial unit beneath the leach pads site is designated Harkers alluvium and is composed of alluvial fan deposits, which are believed to be Pleistocene in age. The site is essentially an erosional surface with a considerable amount of the Harkers alluvium being eroded away in the past. A thin layer of recent alluvium is present at the surface in some areas of the site, particularly within the bottoms of drainages.

The character of the alluvial materials encountered in the exploratory borings is highly variable, as would be expected in an alluvial fan deposit of this type. The predominant soil materials encountered in the borings are composed of gravelly and sandy clays, clayey gravels, and clayey sands with occasional thin layers of silty gravels, silty sand, and relatively clean sands and gravels. The clayey materials encountered generally exhibit moderate to high plasticity. Occasionally, large gravel and cobbles were encountered in the materials described above.

Most of the alluvial materials encountered during the exploratory drilling program were in a slightly moist to moist condition. A slight degree of secondary cementation was encountered in occasional samples, and a marbling effect of calcium carbonate was also observed, especially in the clayey materials.

Below the upper 1 to 5 feet, the granular soils are generally dense to very dense while the fine-grained soils are, in general, firm to hard. However, moderately firm layers or lenses of clays and sandy clays were also observed.

During the site geologic reconnaissance, two locations were identified as having anomalous topography indicative of landslide morphology. These areas are delineated on the site plan presented in Appendix A. The snow cover prevented positive identification that these features are landslide features. If so, the slides would be old (10,000 + years) and appear to be stable at the present time.

4.3.3 Groundwater

No free groundwater was encountered in any of the borings drilled in the area of the waste rock dumps. However, many of the soil materials observed in the borings and test pits were moist to very moist. Further, discontinous perched groundwater was encountered in isolated borings drilled to the east of the site for the heap leach pads, indicating other minor zones of perched water may occur within the waste rock dump site.

5. SEISMICITY

The site is located near the eastern boundary of the seismically active northern portion of the Basin and Range Province of the western United States.

The Basin and Range Province is an extensional system of horsts and grabens forming over an extending crust about 20 to 25 kilometers thick in the site region (Smith, 1979). Systems of high-angle, normal faults separate the horsts and grabens, and similar fault systems with lesser displacements present within the horst and graben blocks.

Regional seismicity maps have been compiled for Utah based on available historical data from 1850 through 1980. An additional computer search for seismicity within the state of Utah was recently performed. These data detect earthquakes of about magnitude 4.5 and larger from 1850 to June, 1962; larger than about magnitude 2.5 from June, 1962 to September, 1974; and since then larger than about magnitude 1.5 in the site region (Richins, 1979). Small to moderate sized earthquakes are numerous in the site region and are associated with the Wasatch fault zone, Basin and Range faults such as those on the west flank of the Oquirrh Range, and events which cannot be assigned to known structures.

In the site area, a moderate sized earthquake (M = 5.2) occurred on September 2, 1962 with a hypocenter located at latitude 40°42.92'N, longitude 112°5.33'W, and a depth of 7 kilometers (Richins, 1979). The epicenter, in the northeast portion of Magna, was about 14 kilometers north of the site. Other smaller events are near this area and are probably aftershocks of the M = 5.2 event. There is no geologically defined structure in the area of this seismicity.

Various published fault maps indicate that active faulting (i.e. faulting in Holocene time - about the last 11,000 years) occurs at the surface in the site region (Bucknam, 1977; Anderson and Miller, 1979). Low-sun-angle (LSA) aerial reconnaissance and field reconnaissance previously performed in the site area has further delineated the active faults in the area. Two major fault systems with Holocene activity are within the site region, the Wasatch Front about 25 kilometers to the east, and the western frontal fault system of the Oquirrh Mountains, about 8 kilometers west of the site.

The Wasatch frontal fault system is well studied (e.g. Arabasz and others, 1979; Smith and others, 1979; Bucknam and others, 1980; Swan and others, 1980; Swan, 1983) and has been assigned a Maximum Credible Earthquake (MCE) of M = 7.6. Recurrence rate for earthquakes along the Wasatch Front have been determined for some segments of the fault zone as between 500 and 2,600 years (Swan and others, 1980). Arabasz and others (1979) estimate for the entire zone an M = 7.5 event occurs every 232 to 263 years. This is not necessarily the segment of the zone adjacent to the site region. Doser and Smith (1982) estimate an M = 6.5 to 7.5 event every 387 to 667 years on one of the segments using geologic moment rates. There have been no historical events with surface rupture on the Wasatch system.

Anderson and Miller (1979) have reported late Quaternary (10,000 to 500,000 years before present) faulting on the northwest flank of the Oquirrh Mountains. Low-sun-angle aerial reconnaissance previously performed shows that the faulting occurs well below the elevation of Lake Bonneville shorelines and displaces the shorelines, indicating that the faulting is less than about 11,000 years old, thus, Holocene in age. The Holocene rupture occurs on a segment of the fault zone which extends from the north end of the Oquirrh Mountains south for a distance of about 23 miles (37 km). At the southern end, the fault is well segmented from the frontal fault system of the southwestern Oquirrh Mountains by a 90 degree change in trend and intersection of the range front by structures associated with South Mountain, the topographic division between the Tooele and Rush Valleys. The frontal fault of the southwestern Oquirrh Mountains is also an active fault, located 16 miles (26 km) from the site at its northern terminus. Wallace (1982) indicates recurrence intervals on Basin and Range faults such as these zones may exceed 10,000 years.

Seismicity in the Magna area suggests the possibility of active faulting; however, low-sun angle aerial reconnaissance and interpretation of 1:24,000 scale color infrared aerial photography indicate that there is no Holocene surface rupture in the area. In the site vicinity older surfaces, probably early Pleistocene in age (0.5 to 1.8 million years before present), show no evidence of surface rupture. Wallace (1982) indicates that moderate to large earthquakes (M greater than about 6.0) are accompanied by surface rupture in the Basin and Range Province. The lack of surface rupture in the Magna area is indicative of no events larger than about M = 6 during the Holocene and at the site during the late Quaternary.

Earthquake sources/source areas considered in the evaluation on site earthquake design parameters are listed in Table 1. These include the segment of the Wasatch fault zone east of the site, the northwest segment of the western frontal fault system of the Oquirrh Mountains, and a source area in the Magna area, defined from historical seismicity. An MCE has been developed for these sources/source areas and the on-site maximum acceleration, in rock, has been calculated. The MCE's are calculated from regressions of Slemmons and others (1982) based on the rationale provided by Slemmons (1977) for the northwest Oquirrh Mountains fault system. MCE's used for the Wasatch frontal fault system developed by Bucknam and others (1980) are adopted for this study. The largest historical event which has occurred for the source area defined by historical seismicity in the Magna area is considered as the MCE.

Recent seismic zonation has been performed by Algermissen and others (1982) of the site area. Effective peak horizontal ground accelerations (A_A) have been estimated for various return intervals as part of this zonation study. A plot of return period versus A_A is presented on Figure 2.

6. STABILITY ANALYSES

Stability analyses were performed for the waste pile in which various potential failure mode considered. Static and seismic analyses were c

TABLE 1

Seismic Design Criteria for the Barneys Canyon Site

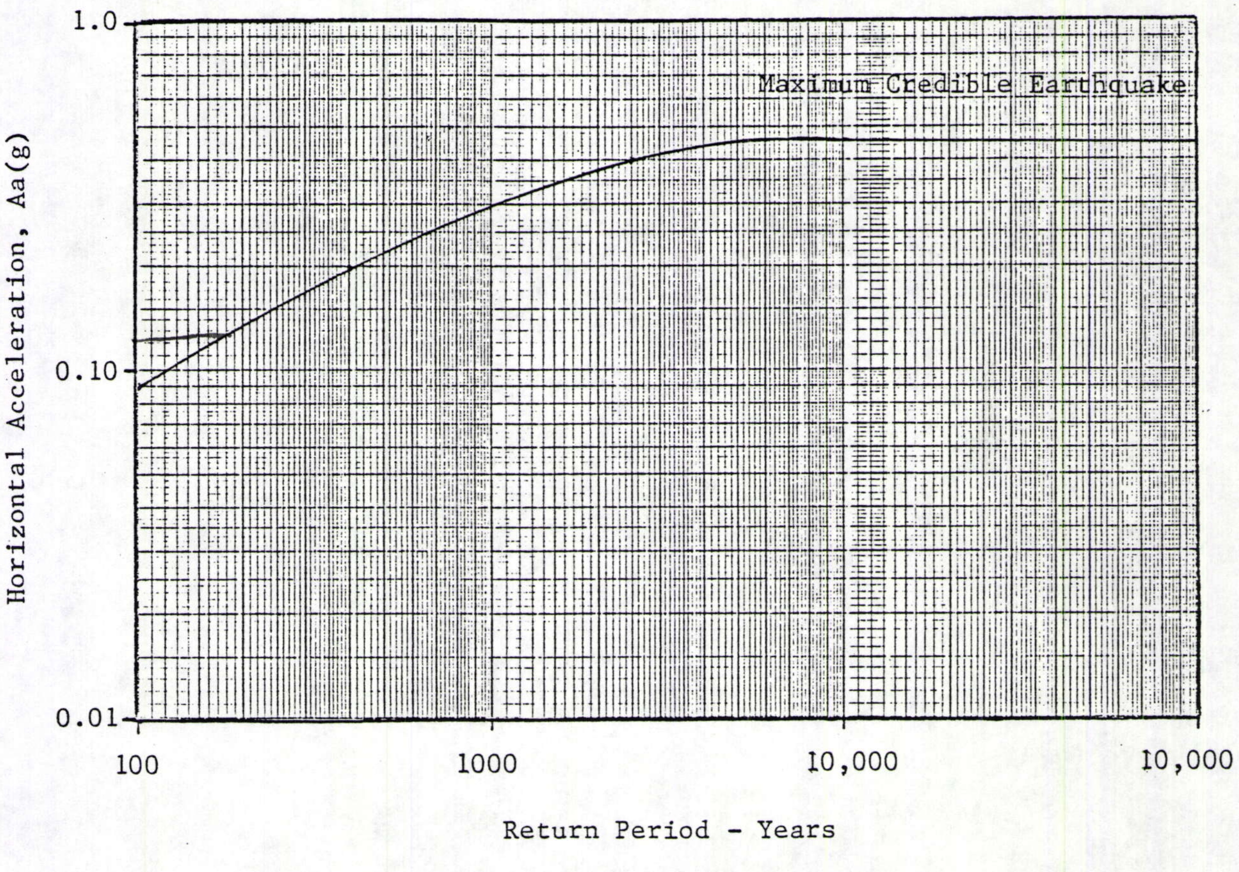
Source/ Source Area	Maximum Length	Maximum Credible[1] Earthquake Magnitude	Distance to Site	Estimated Maximum[2] Acceleration in Rock at Site (Fraction of Unit Gravity)
Wasatch Zone		7.6 (3)	16 Miles (26 km)	0.34 g ± 0.06
Northwest Oquirrh Mountains Zone	24 Miles (39 km)	7.0	4 Miles (6 km)	0.55 g ± 0.06
Magna Source Area		5.2	7 Miles (11 km)	0.16 g ± 0.06
Southwest Oquirrh Mountains Zone	18 Miles (29 km)	6.8	16 Miles (26 km)	0.24 g ± 0.06

1) Calculated from Slemmons and others (1982), normal-slip fault relationship: $M = 0.809 + 1.341 (\log L)$, L = length of fault in meters.

2) Extrapolated from Seed and Idriss (1982).

3) From Bucknam and others (1980).

FIGURE 2 Horizontal Acceleration Versus Return Period



A summary of these analyses, including the major assumptions and factors controlling the analyses are discussed in the following sections.

6.1 Character & Shear Strength of Waste Rock

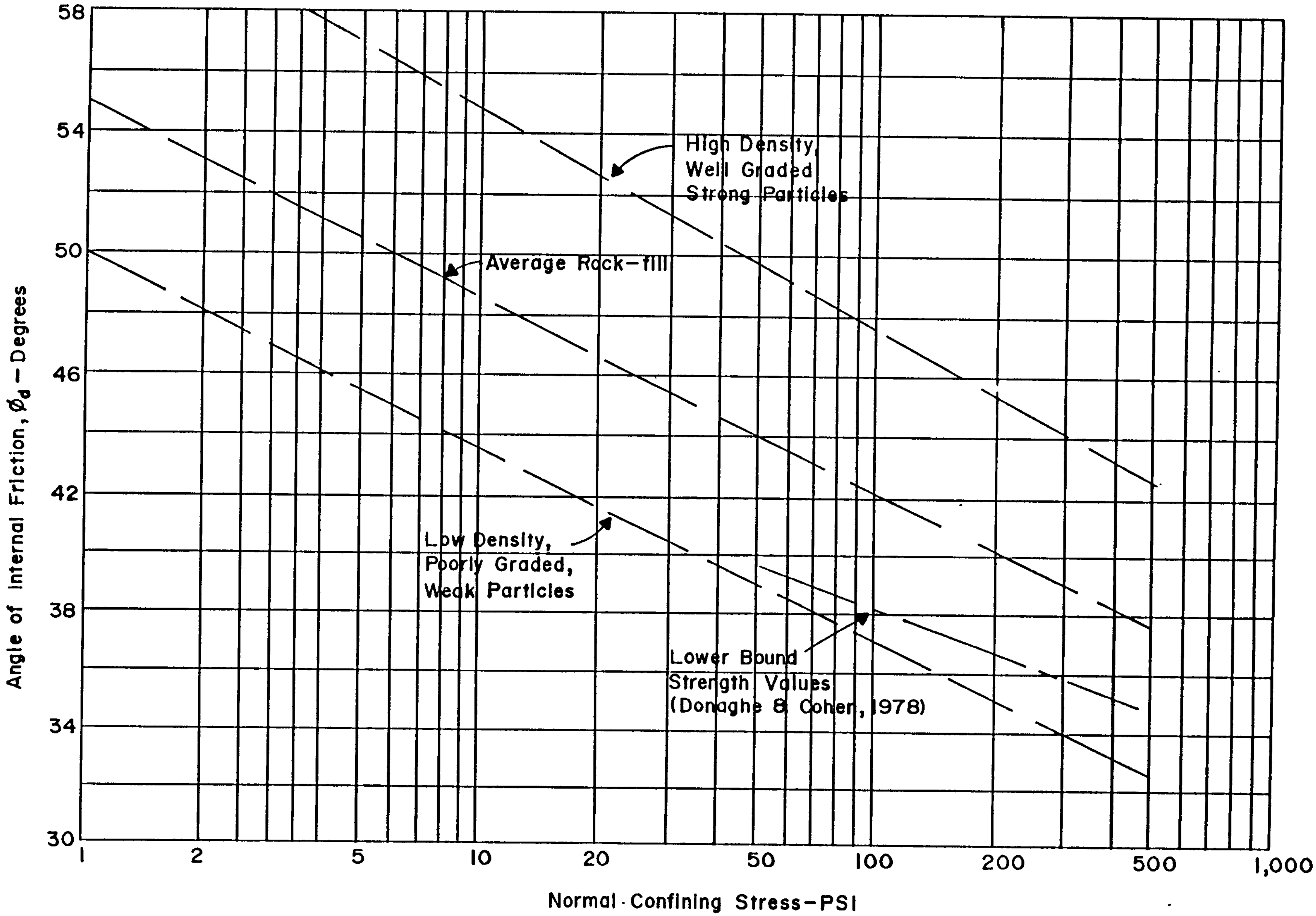
From a review of rock mechanics testing of Barneys Canyon pit rock provided by BP Minerals, the waste rock is expected to generally be a relatively hard and durable material. The weathered and altered zones would result in softer and more clayey materials being incorporated into the waste rock dumps. However, the weaker material would be expected to be sufficiently mixed with the more durable portion such that the strength is not significantly affected.

Dump materials are difficult to test during design because they are not usually accessible for sampling and the rocks involved are highly variable in most ore bodies. Rock involved in dumps for "hard rock" mining of gold, silver, copper, lead, zinc, molybdenum, etc. generally fall within the range of materials which have been tested for rock-fill dam design. A widely used approach in dump design is to conservatively estimate shear strength by study of this data (Call, 1985; Caldwell and others, 1985). This approach was adopted by SHB for the subject project.

Figure 3 represents a summary of the large amount of triaxial shear testing done in the past 38 years on rock-fill materials and reported in the engineering

FIGURE 3

Angle of Internal Friction Versus Confining Stress



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literature. This chart, which has been widely used in dump design, was originally based on a summary of shear strength data on quarried rock and coarse gravels by Leps (1970). Figure 3 shows the relationship between the angle internal friction ($\emptyset_d$) of broken rock and the normal stress across the shear plane (vertical confining pressure). The limits of test data available at the time and the average curve for rock-fill are given on the chart. Subsequent data on the shear strength of rock-fill (Marsal, 1974; Donaghe and Cohen, 1978; Barton and Kjaersli, 1981) are consistent with Figure 3.

The lower limit of tests on seven rock-fill materials performed by the U.S. Army Corps of Engineers (Donaghe and Cohen, 1978) is also shown in Figure 3. This lower limit was defined by weathered, relatively soft granite.

It is believed that the lower bound values in Figure 3 which applies to lower density, poorly graded and weak particles, provides the basis for conservative selection of shear strength for the Barneys Canyon waste rock dump and adequately accounts for effects of weathering of the dump and/or variations in the ore and clayey inclusions.

There is always a possibility there could be a long-term reduction in shear strength; however, with the conservative shear strengths selected for the stability analysis, it is believed that a considerable allowance for the weathering is inherent in the design.

Call (1985) points out that observations of excavations in many old dumps usually indicate that a considerable degree of cementation has been produced by weathering processes. The cohesion created by cementation and clay formation is believed more than compensates for any reduction in $\emptyset_d$ for most dumps.

Detailed studies of the Kennecott Chino leaching dump in New Mexico performed for the U.S. Bureau of Mines (W.A. Wahler & Associates, 1974) provide a case record where a dump has undergone considerable weathering due to leaching, yet has retained high shear strengths. This dump, which has been under construction for about 70 years, has a maximum height of over 435 feet and has end-dump slopes as high as about 200 feet. The dump has not experienced stability problems although it has been extensively leached and has springs emanating from the toe. The dump material consists of heterogeneous gravelly sand with varying amounts of cobbles and boulders and about 10 to 20 percent silty and clayey fines. The plasticity index of the material was generally in the range of 2 to 10 indicating a degree of weathering of the quartz monzonite rocks into clay. The coarse fraction of the dump materials is generally in the range of 6 to 12 inches with some particles being as coarse as 4 feet nominal diameter. Based on a triaxial shear testing program, $\emptyset_d$ = 39 degrees was selected for stability analysis of failure surfaces with a maximum normal stress of about 80 psi. This is somewhat above the lower limit of Figure 3.

6.2 Subgrade Shear Strength

A series of direct shear tests were performed on undisturbed and remolded subgrade samples as part of the investigation for the heap leach pads to the east of the waste rock dumps. Results of the tests on undisturbed samples are presented in Figure 1. It should be noted that the strength values presented for the undisturbed samples can be considered as a lower bound due to the bias in soil sampling. Representative samples could not be obtained of the more well cemented or granular strata; thus the samples tested are inherently the softer materials.

Classification index properties of the samples tested are similar to the subsoils of the waste rock dump sites as are the inplace consistencies as measured by Standard Penetration blow counts. Accordingly, these values are considered representative of the site subsoils.

6.3 Possible Piezometeric Pressure Buildup in the Dump

Considering the height of lift of the dumps and the topography on which they will be constructed, a significant amount of segregation is expected with larger, coarser fragments accumulating at the toe as the heap advances. Thus, a more readily draining zone would be expected to develop at the base of the dump. This zone combined with the relatively steep natural ground grade would aid in draining any water which flows through the dump.

The proposed surface water management plan will divert existing drainages around the dumps. This will result in the only water into the dumps being from infiltration of direct precipitation to the heap. By maintaining proper drainage of the dump surface to facilitate runoff, infiltration can be reduced.

Considering the expected development of a relatively free draining zone at the base of the dump which would act as a blanket drain and the relatively minor inflow of water, it is not expected that a saturated zone will develop in the dumps. Thus, no phreatic surface was considered in the stability analysis.

6.4 Stability Analysis

6.4.1 Modes of Failure

In evaluating the stability of the waste rock pile, three modes of failure are considered critical. The first failure mode is a block slide slope failure with the waste rock sliding along the original ground surface. The second failure mode considered critical is that of a shallow rotational slip entirely within the dump material. The third failure mode is a deep rotational slip through the foundation soils.

Rotational and block failures were analyzed utilizing the computer code STABL2 (Siegel; 1975a, 1975b). This program considers a general shear surface using a limit equilibrium method of slices. For this analysis, the Janbu assumptions for interslice forces were utilized to develop a stability solution which satisfies complete equilibrium. A comparison of the Janbu method of slices with the more rigorous Spencer's method by Siegel (1975a) has demonstrated the Janbu method gives somewhat more conservative results. The factor of safety is generally within 15 percent of that calculated by the Spencer method.

6.4.2 Results of Analysis

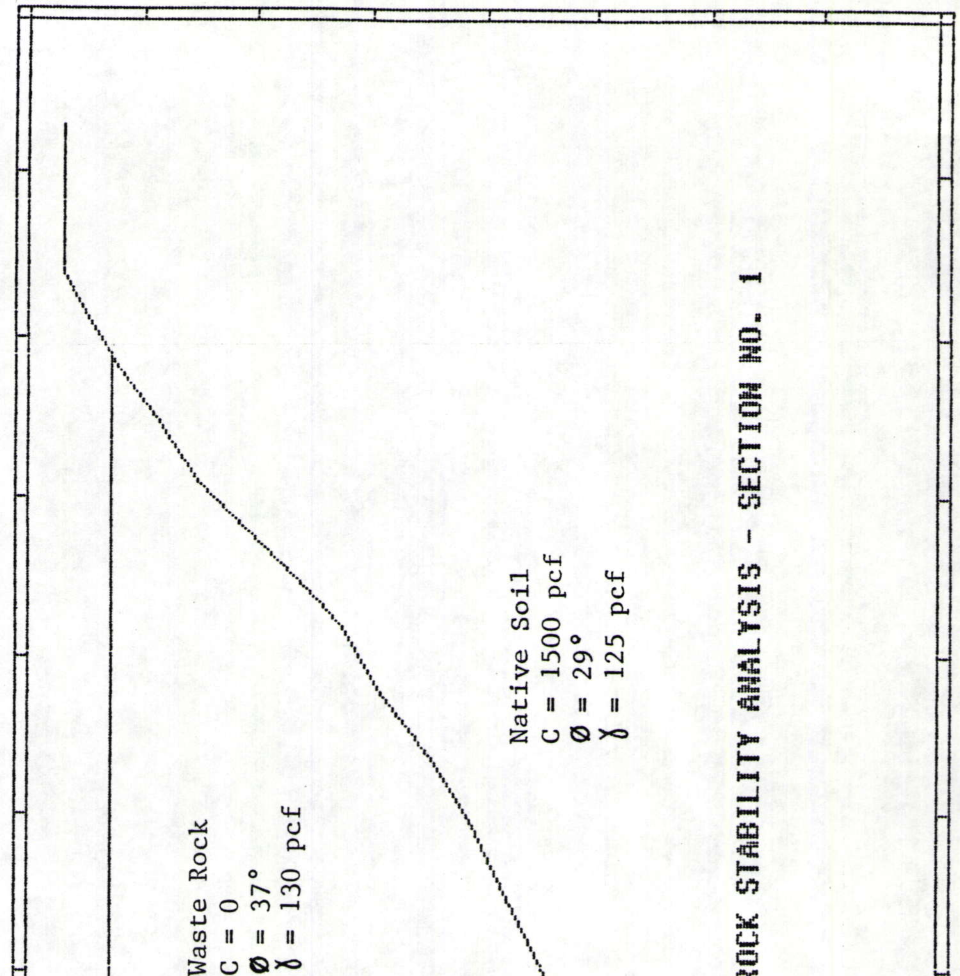
Three sections were selected for consideration in the slope stability evaluation as shown on the site plan in Appendix A. Sections 1 and 3 were identified as the critical slope geometry's of the ultimate height dumps based on original ground slope. Section 2 is considered a critical natural ground geometry for an intermittent phase as the dumps are developed.

Results of the stability analysis considered are presented in Figures 4 through 6, which show slope geometry, strength parameters and the critical slip surface for each of the three failure modes considered.

6.5 Pseudostatic

A psuedostatic solution of the most critical static slip surface was performed for a range of horizontal acceleration of 0.05g to 0.5g to evaluate the seismic stability of the slope. A plot of factor of safety versus horizontal acceleration (Aa) is presented in Figure 7.

FIGURE 4 Stability Analysis for
Section No. 1



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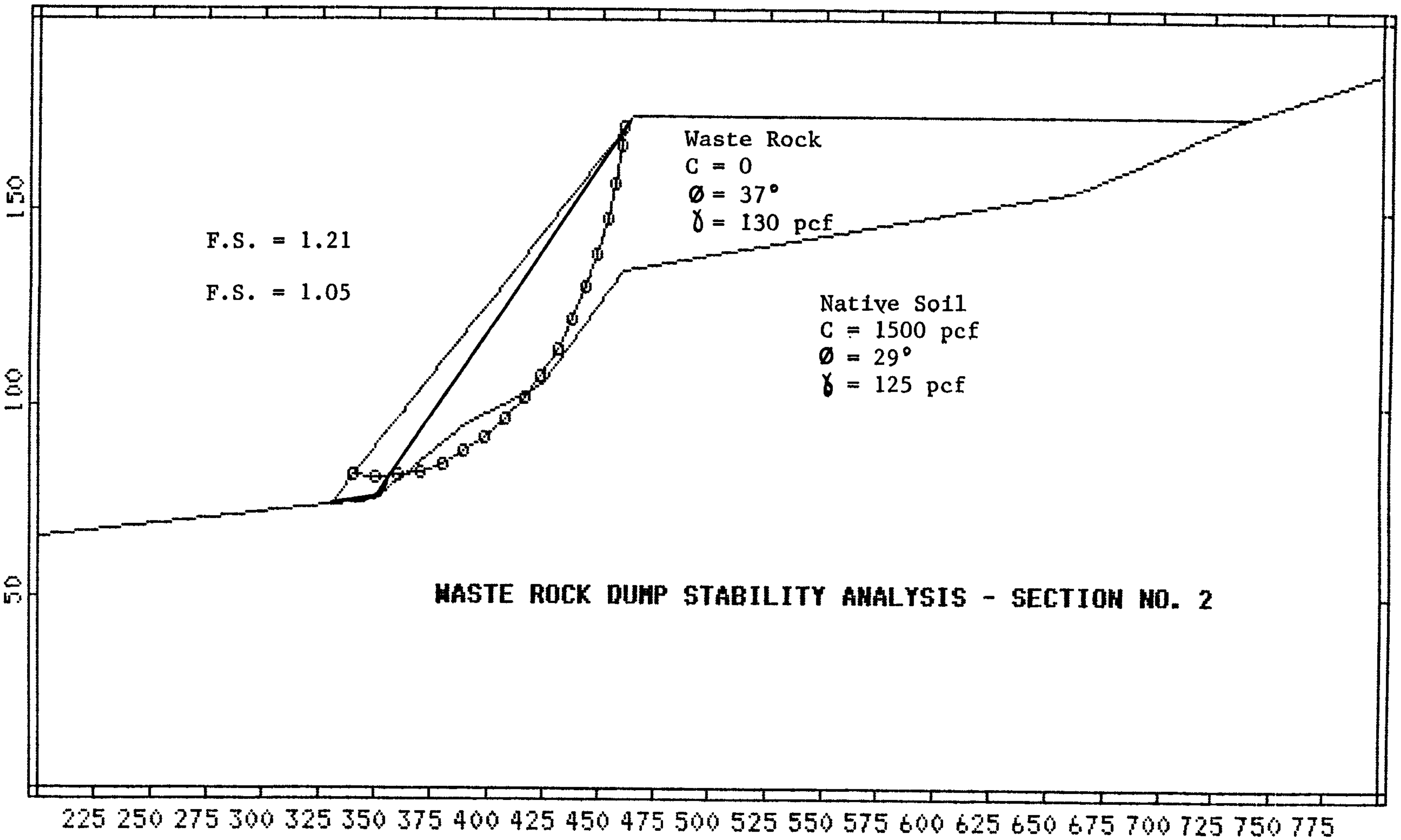

FIGURE 5 Stability Analysis for Section No. 2

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FIGURE 6 Stability Analysis for
Section No. 3

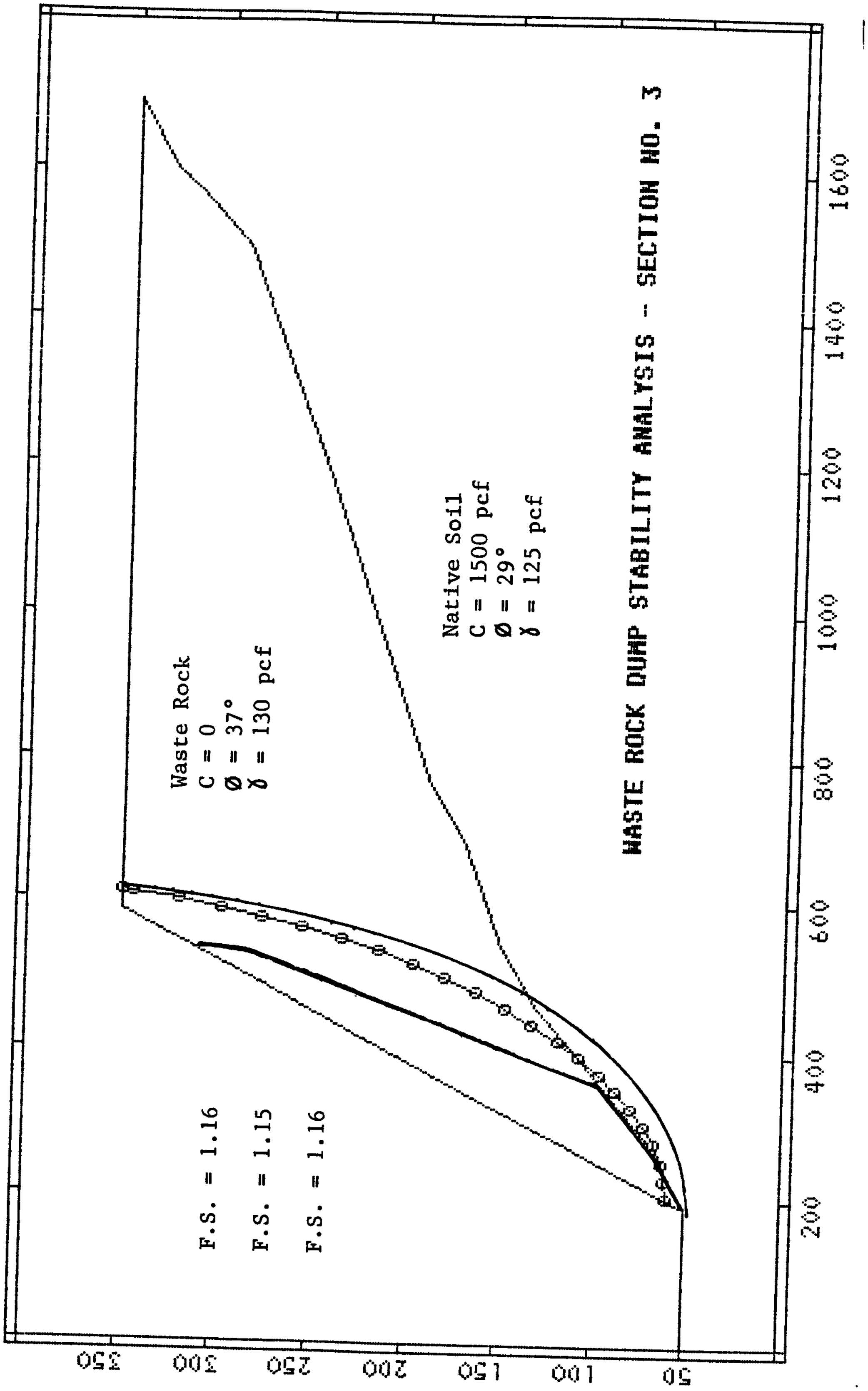
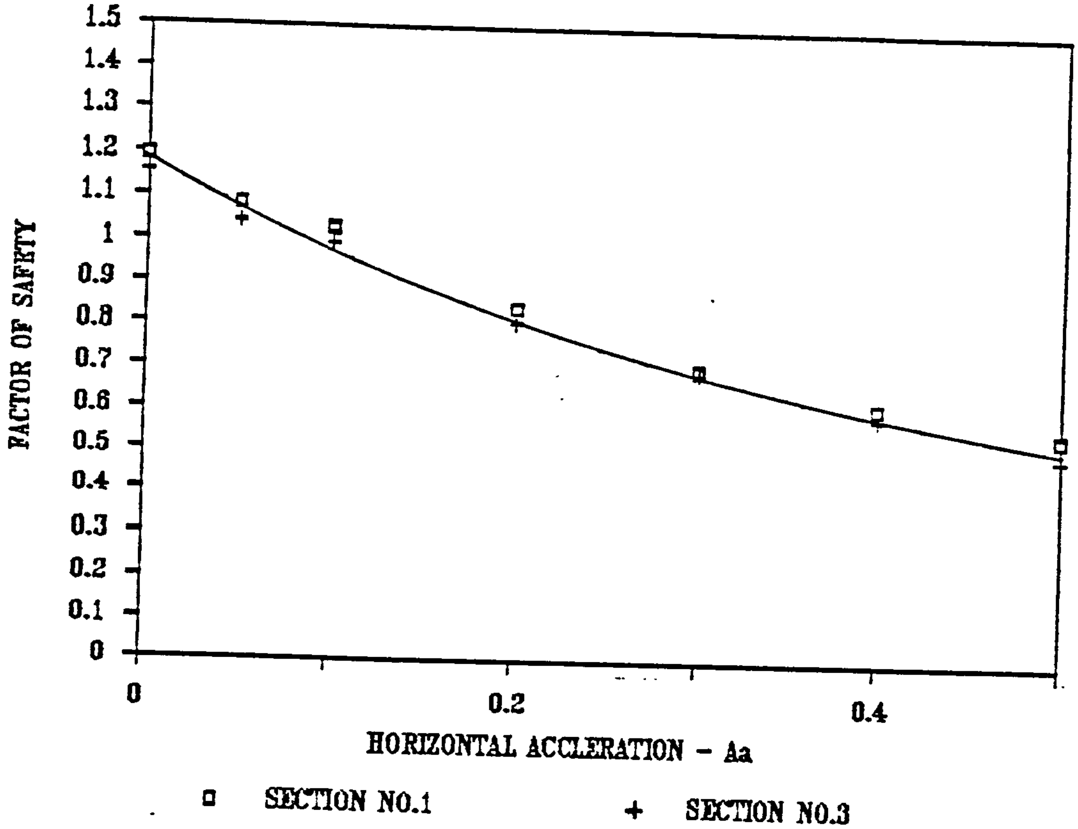


FIGURE 7

FACTOR OF SAFETY VERSUS Aa



In view of the stiff foundation conditions, the proposed waste rock pile is in the category of embankment stability problems where no appreciable reduction of shear strength takes place as deformation occurs under dynamic loads. Thus for horizontal ground acceleration exceeding 0.1g, deformation of the dump would only occur during the application of the seismic forces. Post ground shaking, flow type movements associated with a liquefaction of the waste materials would not be expected to occur.

Permanent deformation-type of analysis (Makdisi and Seed, 1977), a modified pseudostatic method which accounts for the dynamic characteristics of the embankment and the nature of the ground motions created by the design earthquake were used for analysis of the final 1 to 1.32 slope. This type of procedure has been recommended for use in mine dump design by Glass (1981). Parallel to this analysis, performance records of similar embankments under severe earthquake loadings were reviewed and considered in the design. Both the permanent deformation analysis and the review of case histories indicate that permanent deformations under a horizontal acceleration of 0.2 to 0.3g for the critical failure zone would be less than 2 feet. This is considered well within safe limits for the proposed facility.

6.6 Effect of Ancient Landslides

As discussed in Section 3.2, during the geologic reconnaissance of the site, topographic features were identified which may indicate the presence of ancient landslide features as shown on the Site Plan presented in Appendix A. These features could not be definitively identified as landslides due to snow cover. It appears the features developed as a result of down cutting of the arroyo channels.

At the present, the features are considered stable based on the ambiguous landslide morphology. Advancement of the dumps over these areas in a downslope manner could cause reactivation of the slides however, as a result of increasing the driving forces at the slide head. It appears this potential can be mitigated by first advancing the waste dumps as a finger down the drainage to buttress the toe of the slides. At that point the dumps can be advanced in the planned manner by normal downhill construction.

It is recommended that at the time the snow cover melts, a second reconnaissance be performed to further evaluate the potential landslide features to assess their relative stability and better define the geometry. From this, a plan of dump construction could be established to provide buttressing of the slides, if required.

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TEST DRILLING EQUIPMENT AND PROCEDURES

Drilling Equipment Truck-mounted CME-55 drill rigs powered with 4 or 6 cylinder Ford industrial engines are used in advancing test borings. The 4 cylinder and 6 cylinder engines are capable of delivering about 4,350 and 6,500 foot/pounds torque to the drill spindle, respectively. The spindle is advanced with twin hydraulic rams capable of exerting 12,000 pounds downward force. Drilling through soil or softer rock is performed with 6 1/2 O.D., 3 1/4 I.D. hollow stem auger or 4 1/2 inch continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drillings, the holes are sometimes advanced with tricone gear bits and NX rods using water or air as a drilling fluid. Where auger and tricone gear bits cannot be used to advance the hole due to cobbles or caving conditions, the ODEX (overburden drilling with the eccentric method) is used. A percussion down-the-hole hammer underreams the hole and 5 inch steel casing is introduced into the hole during drilling. The drill bit is eccentric and can be removed from the center of the casing to allow sampling of the material below the bit penetration depth.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 procedure. In many cases, 2" O.D., 1 3/8" I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140 pound 30 inch free fall drop hammer required to advance the samplers in 6 inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2 or 3 inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by NX diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

Continuous Penetration Tests Continuous penetrations tests are performed by driving a 2" O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1 5/8" O.D. drill rods to provide clearance to minimize side friction so that penetration values are as near as possible a measure of end resistance. Penetration values are recorded as the number of blows of a 140 pound 30 inch free fall drop hammer required to advance the penetrometer in one foot increments or less.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487) with appropriate group symbols being shown on the logs.

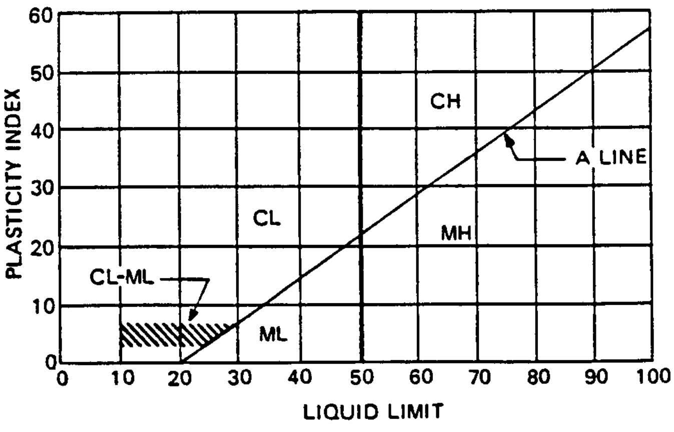
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 seive)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS LIMITS PLOT BELOW "A" LINE & HATCHED ZONE ON PLASTICITY CHART	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CLAYS LIMITS PLOT ABOVE "A" LINE & HATCHED ZONE ON PLASTICITY CHART	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

NOTE: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to ¾ in.
Fine gravel	¾ in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium Stiff	Can be penetrated sev-inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very Firm
50+	Hard

PROJECT BP Minerals Barneys Canyon Project Waste Dumps

JOB NO. E87-2038 B DATE 12-28-87

LOG OF TEST BORING NO. WB-1

RIG TYPE CME-55
BORING TYPE 6½" Hollow Stem Auger
SURFACE ELEV. 6161.4
DATUM Mine

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CH	moist to slightly moist firm	SANDY CLAY with trace of gravel, medium plasticity to high plasticity, tan to dark brown
			X	S	73		15			
5			X	U	59			CL	slightly moist firm to hard	GRAVELLY CLAY, small amount of sand, low plasticity to medium plasticity, tan, orange, light brown
10			X	S	50/3.5"		13	GC	slightly moist dense	CLAYEY SANDY GRAVEL, subangular to angular, well graded, low plasticity, tan, orange, light brown
								GW	slightly moist	GRAVEL, subangular to angular, well graded, light brown, tan, orange (1 foot lense)
15			X	S	48		4			
								SC	slightly moist dense	GRAVELLY CLAYEY SAND, subangular to angular, well graded, low plasticity, tan, orange
20			X	S	50/6"		3			
25										

Stopped auger at 20.0'
Stopped sampler at 21.0'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E87-2038B DATE 12-28-87

LOG OF TEST BORING NO. WB-2

RIG TYPE CME-55
BORING TYPE $6\frac{1}{2}$" Hollow Stem Auger
SURFACE ELEV. 6132.4
DATUM Mine

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification
0								
			X	S	32		14	CH
5			X	U	51			
								SC
10			X	S	15		10	
								GW
15			X	S	36		7	GW
								GC
								CH
20			X	U	34			GC
25								

REMARKS	VISUAL CLASSIFICATION
moist firm to hard	CLAY with small amount of fine grained sand and some gravel, medium plasticity to high plasticity, dark brown to tan, orange.
slightly moist medium dense	CLAYEY GRAVELEY SAND, subangular to angular, well graded, low plasticity, tan, orange
slightly moist	GRAVEL, angular to subangular with minor amounts of sand, well graded, gray
slightly moist dense	SANDY GRAVEL, subangular to angular, moderate to well graded, orange, tan
moist dense	CLAYEY GRAVEL, angular, poorly graded, medium plasticity, orange, light brown
moist firm	CLAY, minor amounts of sand with occasional gravel, medium plasticity, light brown
slightly moist dense	SANDY CLAYEY GRAVEL, subangular to angular, moderate to well graded, low plasticity, orange, light brown
	Auger stopped at 20' Sampler stopped at 21'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E87-2038 B DATE 12-28-87

LOG OF TEST BORING NO. WB 3

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 6144.3

DATUM Mine

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CH	moist to very moist firm	CLAY, small amount of gravel, medium plasticity to high plasticity, orange
			X	U	34					
5			X	S	51		22	CH	moist firm to hard	CLAY with some sand and trace of gravel, medium plasticity, orange and brown to light brown
			X	U	33					
10			X	S	59		18			
15			X	S	43 (no recovery)			CL	moist very firm to hard	GRAVELLY CLAY, minor amounts of sand, medium plasticity, orange, light brown note: increasing gravel and sand with depth to 21.5'
20			X	S	24		16			
25										Stopped auger at 20.0' Stopped sampler at 21.5'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT BP Minerals Barneys Canyon Project Waste Dumps

JOB NO. E87-2038 B DATE 12-22-87

LOG OF TEST BORING NO. WB-4

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. Approximately 6350 ± 10

DATUM Mine

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									slightly moist to moist very firm to hard	CLAY with some to trace of sand, medium plasticity, tan andlight grayish brown
			X	U	35		20			
5			X	S	83/11"		17			
10			X	S	82/11.5"		18	CH		note: high augering resistance in hard clay from 12' to 14' and color change to brown, moderate to high resistance to 20'
15			X	S	61		18			
20			X	S	40		20			
25										Stopped auger at 20.0' Stopped sampler at 21.5'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT BP Minerals Barneys Canyon Project Waste Dumps

JOB NO. E87-2038B DATE 12-22-87

LOG OF TEST BORING NO. WB-5

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. Approximately 6280 ± 10

DATUM Mine

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0–5			X	S	18		3	GM	slightly moist medium dense	SANDY SILTY GRAVEL, well graded, nonplastic, dark brown
5–15			X	S	25		3		slightly moist medium dense to dense	SANDY GRAVEL with silt, well graded, nonplastic, brown, gray and orange
10			X	S	33		7	GM		
15			X	S	76		8	GP	slightly moist dense	GRAVEL with some sand, subangular, brown
20			X	U	45		26	SC	moist dense	CLAYEY SAND with some fine gravel, light yellowish gray

Stopped auger at 20.0'
Stopped sampler at 21.0'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT BP Minerals Barneys Canyon Project
Wast Dumps

JOB NO. E87-2038B DATE 12-22-87

LOG OF TEST BORING NO. WB-6

RIG TYPE CME-55
BORING TYPE 6½" Hollow Stem Auger
SURFACE ELEV. 6546.0
DATUM Mine

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0									moist very firm to hard	CLAYEY SANDY GRAVEL, subrounded gravel, low plasticity to medium plasticity, brown to yellowish-brown
			X	S	32		16	GC		
5			X	S	88/11.5"		19			
									slightly moist dense to very dense	SANDY GRAVEL with some silt, nonplastic, light brown and yellowish brown
10			X	S	50/4"		7	GM		
15									moist very firm to hard	CLAYEY SANDY GRAVEL, low plasticity, subrounded gravel, brown
			X	S	71		26			
								GC		
20			X	U	26		18			
25										Stopped auger at 20.0' Stopped sampler at 21.0' note: 12 inches of material above boring surface was removed by dozer; material consisted of gravelly sandy clay similar to material below boring surface

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive one inch high 2.5 inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inches per minute. The machine is designed to receive one of the one inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

TABULATION OF TEST RESULTS

Job No. E87-2038B **Date** ______

Client: BP Minerals America
1515 Mineral Square
Salt Lake City, Utah 84112

Project BP Minerals Barneys Canyon Project
Waste Rock Dumps

Material ______

Source ______

HOLE NO.	LOCATION	DEPTH	UNIFIED CLASS.	LL	PI	SIEVE ANALYSIS — ACCUM. % PASSING												LAB. NO.
						200	100	40	16	10	4	¼	⅜	¾	1	1½	2	
WB-1	*	2.5-4.0	CH	66	47	55	60	64	69	74	87	95	97	100				7-1
WB-1	*	15.0-16.5	SC			26	32	38	55	49	63	77	82	91	100			7-4
WB-2	*	10.0-11.5	SC	36	23	31	40	48	55	62	76	86	88	97	100			7-8
WB-3	*	5.0-6.5	CH	53	37	87	93	97	98	99	100							7-12
WB-3	*	10.0-11.5	CH	52	40	74	79	81	83	84	87	92	94	95	100			7-14
WB-4	*	20.0-21.5	CH	50	31	93	98	99	99	99	100							7-21
WB-5	*	2.5-4.0	GM			19	28	33	38	42	53	69	77	83	100			7-22
WB-5	*	10.0-11.5	GM			18	25	31	38	44	59	73	80	86	100			7-24
WB-6	*	2.5-4.0	GC			49	54	57	60	63	71	86	100					7-27
WB-6	*	20.0-21.0	GC			33	37	39	41	44	51	60	63	73	85	91	100	7-31

* See Figure A-6

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 16:08: 16

PROBLEM DESCRIPTION WASTE ROCK STABILITY ANALYSIS - SECTION NO. 1

BOUNDARY COORDINATES

7 TOP BOUNDARIES
21 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	44.00	30.00	47.00	2
2	30.00	47.00	100.00	50.00	2
3	100.00	50.00	170.00	57.00	2
4	170.00	57.00	577.00	364.00	1
5	577.00	364.00	1575.00	364.00	1
6	1575.00	364.00	1680.00	384.00	2
7	1680.00	384.00	1860.00	384.00	2
8	170.00	57.00	210.00	63.00	2
9	210.00	63.00	262.00	82.00	2
10	262.00	82.00	435.00	122.00	2
11	435.00	122.00	595.00	143.00	2
12	595.00	143.00	740.00	163.00	2
13	740.00	163.00	860.00	184.00	2
14	860.00	184.00	975.00	204.00	2
15	975.00	204.00	1075.00	224.00	2
16	1075.00	224.00	1150.00	244.00	2
17	1150.00	244.00	1240.00	264.00	2
18	1240.00	264.00	1300.00	284.00	2
19	1300.00	284.00	1415.00	324.00	2
20	1415.00	324.00	1500.00	344.00	2
21	1500.00	344.00	1575.00	364.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING SLIDING BLOCK SURFACES, HAS BEEN SPECIFIED.

50 TRIAL SURFACES HAVE BEEN GENERATED.

3 BOXES SPECIFIED FOR GENERATION OF CENTRAL BLOCK BASE

LENGTH OF LINE SEGMENTS FOR ACTIVE AND PASSIVE PORTIONS OF SLIDING BLOCK IS 15.0

BOX NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	WIDTH (FT)
1	170.00	57.00	170.00	57.00	.00
2	210.00	63.00	262.00	82.00	4.00
3	350.00	102.00	435.00	122.00	5.00

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	251.21	79.13
3	391.91	112.73
4	402.38	123.47
5	409.72	136.56
6	419.60	147.84
7	429.72	158.91
8	439.43	170.34
9	449.98	181.01
10	459.70	192.43
11	469.23	204.02
12	479.70	214.76
13	490.31	225.36
14	499.95	236.86
15	504.82	251.04
16	514.71	262.32
17	525.24	273.00
18	535.79	283.66
19	546.00	294.65
20	553.69	307.53
21	564.21	318.23
22	573.95	329.64
23	582.57	341.91
24	588.52	355.68
25	591.10	364.00

***   1.194 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	220.51	65.15
3	419.76	117.38
4	429.35	128.91
5	439.85	139.62
6	450.36	150.33
7	460.97	160.93
8	471.18	171.92
9	481.47	182.84
10	489.74	195.35
11	496.42	208.78
12	503.96	221.75
13	514.52	232.40
14	519.35	246.60

16	530.88	272.39
17	539.24	284.84
18	546.10	298.18
19	552.25	311.86
20	557.40	325.95
21	567.61	336.94
22	570.75	351.61
23	577.86	364.00

*** 1.232 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	239.34	71.95
3	423.81	119.98
4	430.76	133.27
5	439.94	145.13
6	450.53	155.75
7	460.66	166.82
8	471.18	177.52
9	476.58	191.51
10	484.77	204.08
11	494.98	215.06
12	499.99	229.20
13	504.36	243.55
14	514.96	254.17
15	524.79	265.49
16	534.48	276.95
17	544.10	288.45
18	553.65	300.02
19	563.75	311.11
20	571.33	324.06
21	581.82	334.77
22	592.05	345.74
23	596.28	360.14
24	599.82	364.00

***   1.237 ***

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	234.93	72.34
3	387.56	109.55
4	398.14	120.18
5	408.07	131.42
6	414.40	145.02
7	424.83	155.80
8	434.25	167.47
9	444.84	178.10
10	455.44	188.70
11	456.22	203.68
12	466.60	214.51
13	473.64	227.75
14	483.92	238.68
15	492.61	250.90
16	502.90	261.82
17	508.33	275.80
18	518.94	286.41
19	528.29	298.14
20	538.53	309.10
21	548.98	319.86
22	559.36	330.69

[illegible]	[illegible]	[illegible]
24	568.97	357.92
25	568.99	357.96

*** 1.240 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	241.00	75.07
3	393.16	110.07
4	403.04	121.36
5	409.18	135.04
6	419.78	145.66
7	425.69	159.44
8	432.99	172.55
9	443.52	183.23
10	451.30	196.06
11	458.47	209.23
12	468.51	220.38
13	474.57	234.10
14	478.72	248.51
15	486.41	261.39
16	497.01	272.01
17	507.29	282.93
18	515.26	295.63
19	525.02	307.03
20	531.43	320.59
21	540.77	332.33
22	546.57	341.05

***   1.258 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	235.35	74.20
3	382.43	107.58
4	390.03	120.51
5	399.36	132.26
6	409.97	142.87
7	418.77	155.02
8	427.59	167.15
9	434.32	180.55
10	444.02	192.00
11	454.61	202.62
12	457.43	217.35
13	465.72	229.85
14	476.30	240.49
15	483.29	253.76
16	490.60	266.86
17	495.98	280.86
18	497.00	295.82
19	497.90	304.33

***   1.267 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	250.20	79.54
3	355.25	104.85
4	365.60	115.71
5	370.23	129.97
6	379.89	141.45
7	386.35	154.99
8	394.70	167.45
9	405.27	178.10
10	414.49	189.92
11	424.01	201.51
12	432.42	213.94
13	439.64	227.09
14	450.24	237.70
15	456.72	251.22
16	458.74	266.09
17	469.24	276.80
18	470.06	283.33

*** 1.268 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	250.51	78.71
3	428.79	119.33
4	438.75	130.55
5	443.69	144.71
6	454.29	155.33
7	464.86	165.97
8	475.16	176.88
9	479.85	191.13
10	488.65	203.27
11	498.83	214.29
12	508.76	225.53
13	516.89	238.14
14	519.03	252.98
15	527.37	265.45
16	537.25	276.73
17	542.24	290.88
18	552.64	301.69
19	559.48	315.04
20	560.10	330.03
21	570.29	341.04
22	571.27	356.00
23	577.70	364.00

*** 1.271 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	212.80	63.91
3	380.11	110.89
4	390.38	121.81
5	396.50	135.51
6	404.28	148.33
7	412.30	161.01
8	422.75	171.77
9	427.78	185.90
10	436.80	197.89
11	445.70	209.96
12	452.61	223.27
13	461.57	235.30
14	467.19	249.21
15	476.88	260.66
16	486.00	272.57
17	494.64	284.84
18	504.97	295.71
19	506.11	310.53

*** 1.278 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	170.00	57.00
2	237.00	73.01
3	426.63	120.61
4	429.72	135.29
5	437.68	148.00
6	444.81	161.20
7	455.26	171.97
8	465.74	182.69
9	476.35	193.30
10	486.85	204.01
11	494.97	216.62
12	505.56	227.25
13	510.82	241.29
14	521.21	252.11
15	529.43	264.66
16	538.57	276.55
17	547.46	288.64
18	555.72	301.16
19	558.71	315.86
20	560.25	330.78
21	562.98	345.53
22	564.31	354.43

*** 1.283 ***

```
           Y            A     X     I     S            F     T

            .00    232.50    465.00    697.50    930.00   1162.50

X       .00 +-*-------+---------+---------+---------+---------+
            - *
            -
            - *
            - *
            -  *
     232.50 +  1
            -  .*
            -
            -   .7.
            -    1677
            -    *11477.
A    465.00 +     2211457.
            -       221145.
            -          31125
            -     *      311*
            -
            -
X    697.50 +
            -      *
            -
            -
            -       *
            -
I    930.00 +
            -        *
            -
            -
            -         *
            -
S   1162.50 +         *
            -
            -          *
            -
            -           *
            -
    1395.00 +
            -             *
            -
            -              *
            -
            -               *
F   1627.50 +
            -                *
            -
            -
            -
            -
T   1860.00 +                *
```

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 16:10: 13

PROBLEM DESCRIPTION WASTE ROCK STABILITY ANALYSIS - SECTION NO. 1

BOUNDARY COORDINATES

7 TOP BOUNDARIES
21 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	44.00	30.00	47.00	2
2	30.00	47.00	100.00	50.00	2
3	100.00	50.00	170.00	57.00	2
4	170.00	57.00	577.00	364.00	1
5	577.00	364.00	1575.00	364.00	1
6	1575.00	364.00	1680.00	384.00	2
7	1680.00	384.00	1860.00	384.00	2
8	170.00	57.00	210.00	63.00	2
9	210.00	63.00	262.00	82.00	2
10	262.00	82.00	435.00	122.00	2
11	435.00	122.00	595.00	143.00	2
12	595.00	143.00	740.00	163.00	2
13	740.00	163.00	860.00	184.00	2
14	860.00	184.00	975.00	204.00	2
15	975.00	204.00	1075.00	224.00	2
16	1075.00	224.00	1150.00	244.00	2
17	1150.00	244.00	1240.00	264.00	2
18	1240.00	264.00	1300.00	284.00	2
19	1300.00	284.00	1415.00	324.00	2
20	1415.00	324.00	1500.00	344.00	2
21	1500.00	344.00	1575.00	364.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 165.00 FT.
AND X = 300.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 550.00 FT.
AND X = 800.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 30.00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND 5.0 DEG.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 37 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	285.00	143.74
2	294.98	144.43
3	304.92	145.45
4	314.83	146.80
5	324.69	148.49
6	334.48	150.51
7	344.20	152.86
8	353.84	155.53
9	363.38	158.52
10	372.82	161.84
11	382.13	165.47
12	391.32	169.41
13	400.37	173.66
14	409.28	178.22
15	418.02	183.07
16	426.60	188.21
17	435.00	193.63
18	443.21	199.34
19	451.23	205.32
20	459.04	211.57
21	466.63	218.07
22	474.00	224.83
23	481.14	231.84
24	488.04	239.07
25	494.69	246.54
26	501.09	254.23
27	507.22	262.13
28	513.08	270.23
29	518.67	278.52
30	523.98	286.99
31	529.00	295.64
32	533.72	304.46
33	538.14	313.43
34	542.26	322.54
35	546.07	331.78
36	549.57	341.15
37	550.54	344.04

***   1.118 ***

FAILURE SURFACE SPECIFIED BY 53 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	195.00	75.86
2	204.84	74.07

4	224.66	71.45
5	234.63	70.63
6	244.62	70.13
7	254.62	69.96
8	264.62	70.12
9	274.60	70.59
10	284.57	71.40
11	294.51	72.53
12	304.40	73.98
13	314.24	75.75
14	324.02	77.84
15	333.73	80.25
16	343.35	82.97
17	352.88	86.00
18	362.30	89.35
19	371.62	92.99
20	380.80	96.94
21	389.86	101.19
22	398.77	105.73
23	407.53	110.55
24	416.12	115.66
25	424.55	121.05
26	432.80	126.70
27	440.85	132.62
28	448.71	138.81
29	456.37	145.24
30	463.81	151.92
31	471.03	158.84
32	478.02	165.99
33	484.78	173.36
34	491.29	180.95
35	497.55	188.74
36	503.56	196.74
37	509.30	204.93
38	514.77	213.30
39	519.97	221.84
40	524.88	230.55
41	529.51	239.42
42	533.85	248.42
43	537.89	257.57
44	541.64	266.84
45	545.08	276.23
46	548.21	285.73
47	551.03	295.32
48	553.54	305.00
49	555.73	314.76
50	557.60	324.58
51	559.16	334.46
52	560.39	344.39
53	561.08	351.99

*** 1.209 ***

FAILURE SURFACE SPECIFIED BY 54 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	210.00	87.17
2	219.84	85.38
3	229.73	83.90
4	239.66	82.73
5	249.62	81.88
6	259.61	81.34
7	269.61	81.12
8	279.61	81.22
9	289.60	81.63
10	299.57	82.36
11	309.52	83.40
12	319.42	84.76
13	329.28	86.43
14	339.08	88.42
15	348.82	90.71
16	358.47	93.31
17	368.04	96.21
18	377.52	99.42
19	386.88	102.92
20	396.13	106.72
21	405.26	110.80
22	414.25	115.18
23	423.10	119.84
24	431.80	124.77
25	440.33	129.98
26	448.70	135.46
27	456.89	141.20
28	464.90	147.19
29	472.71	153.43
30	480.32	159.92
31	487.72	166.65
32	494.90	173.61
33	501.86	180.79
34	508.59	188.19
35	515.08	195.79
36	521.32	203.60
37	527.32	211.60
38	533.06	219.79
39	538.54	228.16
40	543.75	236.69
41	548.69	245.39
42	553.35	254.24
43	557.73	263.23
44	561.82	272.35
45	565.62	281.60
46	569.12	290.97
47	572.33	300.44
48	575.24	310.01
49	577.84	319.66
50	580.13	329.40
51	582.12	339.20
52	583.79	349.06
53	585.15	358.96
54	585.69	364.00

*** 1.216 ***

FAILURE SURFACE SPECIFIED BY 48 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	255.00	121.12
2	264.94	120.01
3	274.91	119.22
4	284.90	118.76
5	294.90	118.62
6	304.89	118.81
7	314.88	119.32
8	324.85	120.15
9	334.78	121.31
10	344.67	122.78
11	354.51	124.58
12	364.28	126.69
13	373.98	129.12
14	383.60	131.86
15	393.12	134.91
16	402.54	138.27
17	411.85	141.93
18	421.03	145.88
19	430.08	150.14
20	438.99	154.68
21	447.74	159.52
22	456.34	164.63
23	464.76	170.02
24	473.01	175.67
25	481.07	181.60
26	488.93	187.78
27	496.59	194.21
28	504.03	200.88
29	511.26	207.79
30	518.26	214.94
31	525.02	222.30
32	531.54	229.88
33	537.82	237.67
34	543.83	245.66
35	549.59	253.84
36	555.08	262.20
37	560.29	270.73
38	565.23	279.43
39	569.88	288.28
40	574.24	297.28
41	578.31	306.41
42	582.08	315.67
43	585.55	325.05
44	588.71	334.54
45	591.57	344.12
46	594.11	353.79
47	596.34	363.54
48	596.43	364.00

***   1.223 ***

FAILURE SURFACE SPECIFIED BY 59 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	195.00	75.86
2	204.93	74.69
3	214.89	73.78
4	224.87	73.11
5	234.86	72.69
6	244.86	72.52
7	254.86	72.60
8	264.85	72.93
9	274.84	73.50
10	284.80	74.33
11	294.74	75.40
12	304.66	76.72
13	314.53	78.28
14	324.37	80.09
15	334.15	82.15
16	343.89	84.45
17	353.56	86.99
18	363.17	89.76
19	372.70	92.78
20	382.15	96.04
21	391.53	99.52
22	400.81	103.24
23	410.00	107.19
24	419.08	111.37
25	428.06	115.77
26	436.93	120.40
27	445.68	125.24
28	454.30	130.30
29	462.80	135.57
30	471.16	141.06
31	479.38	146.75
32	487.46	152.64
33	495.39	158.73
34	503.17	165.02
35	510.79	171.50
36	518.24	178.16
37	525.53	185.01
38	532.64	192.04
39	539.58	199.24
40	546.33	206.62
41	552.90	214.16
42	559.28	221.86
43	565.47	229.72
44	571.45	237.73
45	577.24	245.88
46	582.82	254.18
47	588.20	262.61
48	593.36	271.18
49	598.31	279.87
50	603.04	288.68
51	607.55	297.60
52	611.83	306.64
53	615.89	315.78
54	619.72	325.01
55	623.32	334.34
56	626.69	343.76
57	629.82	353.26
58	632.71	362.83

*** 1.227 ***

FAILURE SURFACE SPECIFIED BY 47 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	270.00	132.43
2	280.00	132.70
3	289.98	133.22
4	299.95	133.97
5	309.91	134.96
6	319.83	136.19
7	329.72	137.66
8	339.57	139.37
9	349.38	141.31
10	359.14	143.48
11	368.85	145.89
12	378.49	148.54
13	388.07	151.41
14	397.58	154.51
15	407.01	157.84
16	416.36	161.39
17	425.62	165.17
18	434.78	169.17
19	443.85	173.38
20	452.81	177.82
21	461.67	182.46
22	470.41	187.32
23	479.03	192.39
24	487.53	197.66
25	495.90	203.14
26	504.13	208.81
27	512.23	214.68
28	520.18	220.74
29	527.99	226.99
30	535.64	233.43
31	543.13	240.05
32	550.47	246.84
33	557.64	253.81
34	564.64	260.95
35	571.47	268.26
36	578.12	275.73
37	584.59	283.35
38	590.87	291.13
39	596.97	299.06
40	602.87	307.13
41	608.58	315.34
42	614.09	323.69
43	619.40	332.16
44	624.50	340.76
45	629.40	349.48
46	634.08	358.32
47	636.93	364.00

*** 1.237 ***

FAILURE SURFACE SPECIFIED BY 47 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	255.00	121.12
2	264.88	119.56
3	274.81	118.36
4	284.77	117.51
5	294.76	117.01
6	304.76	116.86
7	314.75	117.07
8	324.74	117.62
9	334.70	118.53
10	344.62	119.79
11	354.49	121.40
12	364.29	123.36
13	374.03	125.66
14	383.67	128.30
15	393.22	131.28
16	402.65	134.60
17	411.96	138.24
18	421.14	142.22
19	430.17	146.51
20	439.05	151.12
21	447.75	156.04
22	456.28	161.26
23	464.62	166.78
24	472.76	172.59
25	480.68	178.69
26	488.39	185.06
27	495.87	191.69
28	503.11	198.59
29	510.10	205.74
30	516.84	213.13
31	523.31	220.75
32	529.51	228.60
33	535.43	236.66
34	541.06	244.93
35	546.39	253.39
36	551.43	262.03
37	556.15	270.84
38	560.56	279.81
39	564.66	288.94
40	568.43	298.20
41	571.87	307.59
42	574.97	317.10
43	577.74	326.70
44	580.17	336.40
45	582.25	346.19
46	583.99	356.03
47	585.11	364.00

***   1.242 ***

FAILURE SURFACE SPECIFIED BY 56 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)

1	210.00	87.17
2	220.00	86.90
3	230.00	86.84
4	239.99	87.01
5	249.99	87.41
6	259.97	88.03
7	269.93	88.87
8	279.87	89.94
9	289.79	91.23
10	299.68	92.74
11	309.53	94.47
12	319.33	96.42
13	329.09	98.60
14	338.80	100.99
15	348.46	103.59
16	358.05	106.42
17	367.58	109.45
18	377.04	112.70
19	386.42	116.17
20	395.72	119.84
21	404.94	123.71
22	414.07	127.80
23	423.10	132.09
24	432.04	136.58
25	440.87	141.26
26	449.59	146.15
27	458.21	151.23
28	466.71	156.50
29	475.08	161.96
30	483.34	167.61
31	491.46	173.44
32	499.45	179.45
33	507.31	185.64
34	515.02	192.00
35	522.59	198.54
36	530.01	205.24
37	537.28	212.11
38	544.39	219.13
39	551.35	226.32
40	558.14	233.66
41	564.76	241.15
42	571.22	248.79
43	577.50	256.57
44	583.61	264.49
45	589.54	272.54
46	595.28	280.73
47	600.84	289.04
48	606.22	297.47
49	611.40	306.02
50	616.39	314.69
51	621.18	323.47
52	625.78	332.35
53	630.17	341.33
54	634.37	350.41
55	638.35	359.58
56	640.16	364.00

*** 1.244 ***

FAILURE SURFACE SPECIFIED BY 65 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	165.00	56.50
2	174.76	54.33
3	184.57	52.40
4	194.43	50.73
5	204.33	49.31
6	214.26	48.14
7	224.22	47.23
8	234.20	46.57
9	244.19	46.16
10	254.19	46.01
11	264.19	46.12
12	274.18	46.47
13	284.16	47.09
14	294.13	47.96
15	304.06	49.08
16	313.97	50.45
17	323.84	52.08
18	333.66	53.96
19	343.43	56.08
20	353.14	58.46
21	362.79	61.08
22	372.37	63.95
23	381.88	67.06
24	391.30	70.41
25	400.63	74.01
26	409.87	77.83
27	419.01	81.90
28	428.04	86.19
29	436.96	90.71
30	445.76	95.46
31	454.43	100.43
32	462.98	105.63
33	471.39	111.03
34	479.66	116.65
35	487.79	122.48
36	495.76	128.52
37	503.58	134.75
38	511.24	141.19
39	518.73	147.81
40	526.04	154.63
41	533.19	161.63
42	540.15	168.80
43	546.92	176.16
44	553.51	183.68
45	559.90	191.37
46	566.10	199.22
47	572.09	207.23
48	577.88	215.39
49	583.45	223.69
50	588.82	232.13
51	593.96	240.70
52	598.89	249.40
53	603.59	258.23
54	608.07	267.17
55	612.31	276.22
56	616.33	285.38
57	620.11	294.64
58	623.65	303.99

60	630.01	322.95
61	632.83	332.55
62	635.40	342.21
63	637.73	351.94
64	639.80	361.72
65	640.23	364.00

***   1.249 ***

FAILURE SURFACE SPECIFIED BY 46 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	240.00	109.80
2	249.79	107.77
3	259.66	106.12
4	269.58	104.86
5	279.54	103.98
6	289.52	103.50
7	299.52	103.40
8	309.52	103.69
9	319.50	104.37
10	329.44	105.44
11	339.33	106.89
12	349.16	108.73
13	358.91	110.95
14	368.57	113.55
15	378.12	116.52
16	387.54	119.86
17	396.83	123.57
18	405.97	127.63
19	414.94	132.05
20	423.73	136.81
21	432.34	141.91
22	440.73	147.34
23	448.91	153.10
24	456.86	159.17
25	464.56	165.54
26	472.02	172.21
27	479.20	179.16
28	486.11	186.39
29	492.74	193.88
30	499.06	201.63
31	505.08	209.61
32	510.79	217.82
33	516.17	226.25
34	521.22	234.88
35	525.93	243.70
36	530.29	252.70
37	534.30	261.86
38	537.95	271.17
39	541.24	280.62
40	544.15	290.18
41	546.69	299.86
42	548.85	309.62
43	550.63	319.46
44	552.03	329.36
45	553.03	339.31
46	553.46	346.25

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                Y          A    X    I    S          F    T


                   .00    232.50    465.00    697.50    930.00   1162.50

 X       .00 +-*-------+---------+---------+---------+---------+
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             -..92241
             -..99*2411
 A    465.00 +...9522411
             -....99222111
             - .....953221111
             - ....*..9553333*
             -  ........955555
             -   ............8
 X    697.50 +    ............
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 I    930.00 +
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 F   1627.50 +
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 T   1860.00 +                 *
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--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 16:21: 44

PROBLEM DESCRIPTION WASTE ROCK STABILITY ANALYSIS - SECTION NO. 1

BOUNDARY COORDINATES

7 TOP BOUNDARIES
21 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	44.00	30.00	47.00	2
2	30.00	47.00	100.00	50.00	2
3	100.00	50.00	170.00	57.00	2
4	170.00	57.00	577.00	364.00	1
5	577.00	364.00	1575.00	364.00	1
6	1575.00	364.00	1680.00	384.00	2
7	1680.00	384.00	1860.00	384.00	2
8	170.00	57.00	210.00	63.00	2
9	210.00	63.00	262.00	82.00	2
10	262.00	82.00	435.00	122.00	2
11	435.00	122.00	595.00	143.00	2
12	595.00	143.00	740.00	163.00	2
13	740.00	163.00	860.00	184.00	2
14	860.00	184.00	975.00	204.00	2
15	975.00	204.00	1075.00	224.00	2
16	1075.00	224.00	1150.00	244.00	2
17	1150.00	244.00	1240.00	264.00	2
18	1240.00	264.00	1300.00	284.00	2
19	1300.00	284.00	1415.00	324.00	2
20	1415.00	324.00	1500.00	344.00	2
21	1500.00	344.00	1575.00	364.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X =   .00 FT.
AND X = 400.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 700.00 FT.
AND X = 800.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y =   .00 FT.

20.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND   5.0 DEG.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL
FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 38 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	88.89	49.52
2	108.82	47.88
3	128.80	46.86
4	148.79	46.48
5	168.79	46.72
6	188.77	47.60
7	208.71	49.10
8	228.60	51.24
9	248.41	54.00
10	268.12	57.38
11	287.72	61.38
12	307.18	66.00
13	326.48	71.23
14	345.61	77.06
15	364.55	83.50
16	383.27	90.53
17	401.76	98.15
18	420.01	106.34
19	437.98	115.11
20	455.67	124.44
21	473.06	134.32
22	490.13	144.75
23	506.86	155.71
24	523.23	167.19
25	539.24	179.18
26	554.86	191.67
27	570.08	204.65
28	584.88	218.10
29	599.25	232.01
30	613.18	246.36
31	626.64	261.15
32	639.63	276.36
33	652.14	291.96
34	664.15	307.96
35	675.65	324.32
36	686.62	341.04
37	697.06	358.10
38	700.43	364.00

*** 1.326 ***

FAILURE SURFACE SPECIFIED BY 39 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	88.89	49.52

3	128.44	43.57
4	148.34	41.64
5	168.31	40.40
6	188.30	39.86
7	208.30	40.03
8	228.28	40.89
9	248.22	42.45
10	268.09	44.71
11	287.87	47.66
12	307.54	51.30
13	327.06	55.63
14	346.42	60.64
15	365.60	66.32
16	384.56	72.68
17	403.30	79.69
18	421.77	87.35
19	439.96	95.66
20	457.86	104.59
21	475.42	114.15
22	492.65	124.32
23	509.51	135.08
24	525.98	146.42
25	542.04	158.34
26	557.67	170.81
27	572.86	183.82
28	587.59	197.35
29	601.83	211.40
30	615.58	225.93
31	628.80	240.93
32	641.49	256.39
33	653.64	272.28
34	665.22	288.58
35	676.22	305.28
36	686.63	322.36
37	696.44	339.79
38	705.63	357.55
39	708.68	364.00

*** 1.332 ***

FAILURE SURFACE SPECIFIED BY 34 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	177.78	62.87
2	197.75	63.88
3	217.69	65.46
4	237.57	67.61
5	257.39	70.34
6	277.11	73.64
7	296.74	77.50
8	316.24	81.92
9	335.61	86.90
10	354.83	92.44
11	373.88	98.53
12	392.75	105.16
13	411.42	112.33
14	429.87	120.04
15	448.10	128.27
16	466.08	137.03
17	483.81	146.30
18	501.25	156.07
19	518.42	166.34
20	535.27	177.10
21	551.82	188.34
22	568.03	200.05
23	583.90	212.23
24	599.41	224.85
25	614.55	237.91
26	629.31	251.41
27	643.68	265.32
28	657.64	279.64
29	671.19	294.36
30	684.30	309.46
31	696.98	324.93
32	709.20	340.76
33	720.97	356.93
34	725.80	364.00

*** 1.359 ***

FAILURE SURFACE SPECIFIED BY 43 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	.00	44.00
2	19.59	39.99
3	39.30	36.58
4	59.10	33.78
5	78.98	31.60
6	98.92	30.04
7	118.90	29.09
8	138.90	28.76
9	158.90	29.05
10	178.88	29.95
11	198.82	31.48
12	218.70	33.62

[illegible]	[illegible]	39.74
15	277.83	43.72
16	297.30	48.30
17	316.61	53.48
18	335.76	59.25
19	354.72	65.62
20	373.48	72.56
21	392.01	80.09
22	410.30	88.18
23	428.33	96.84
24	446.08	106.05
25	463.54	115.80
26	480.69	126.09
27	497.51	136.91
28	513.99	148.24
29	530.12	160.07
30	545.87	172.40
31	561.23	185.21
32	576.18	198.49
33	590.72	212.22
34	604.83	226.40
35	618.49	241.01
36	631.69	256.03
37	644.42	271.45
38	656.67	287.26
39	668.43	303.44
40	679.67	319.98
41	690.40	336.86
42	700.61	354.06
43	706.10	364.00

***   1.372 ***

FAILURE SURFACE SPECIFIED BY 30 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	222.22	96.39
2	242.16	97.90
3	262.05	100.03
4	281.86	102.78
5	301.58	106.14
6	321.18	110.10
7	340.65	114.68
8	359.97	119.85
9	379.12	125.62
10	398.08	131.98
11	416.84	138.93
12	435.37	146.45
13	453.66	154.54
14	471.69	163.20
15	489.44	172.41
16	506.90	182.17
17	524.05	192.46
18	540.87	203.28
19	557.34	214.62
20	573.46	226.46
21	589.20	238.79
22	604.56	251.61
23	619.51	264.90
24	634.04	278.64
25	648.13	292.83
26	661.78	307.44
27	674.97	322.48
28	687.69	337.91
29	699.93	353.73
30	707.37	364.00

***   1.377 ***

FAILURE SURFACE SPECIFIED BY 38 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	133.33	53.33
2	153.23	51.31
3	173.18	49.95
4	193.17	49.24
5	213.17	49.19
6	233.16	49.80
7	253.12	51.06
8	273.03	52.98
9	292.86	55.56
10	312.60	58.79
11	332.22	62.66
12	351.71	67.18
13	371.03	72.33
14	390.17	78.12
15	409.12	84.54
16	427.84	91.57

[illegible]	[illegible]	107.47
19	482.47	116.32
20	500.11	125.75
21	517.43	135.76
22	534.40	146.33
23	551.02	157.46
24	567.27	169.12
25	583.12	181.32
26	598.57	194.02
27	613.58	207.23
28	628.16	220.93
29	642.27	235.10
30	655.91	249.72
31	669.07	264.79
32	681.72	280.28
33	693.85	296.18
34	705.45	312.47
35	716.52	329.13
36	727.02	346.15
37	736.97	363.50
38	737.23	364.00

*** 1.377 ***

FAILURE SURFACE SPECIFIED BY 40 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	44.44	47.62
2	64.42	46.55
3	84.41	46.02
4	104.41	46.02
5	124.40	46.55
6	144.37	47.62
7	164.31	49.22
8	184.20	51.34
9	204.02	54.00
10	223.76	57.18
11	243.42	60.89
12	262.97	65.12
13	282.39	69.86
14	301.69	75.13
15	320.84	80.90
16	339.82	87.19
17	358.64	93.97
18	377.26	101.26
19	395.69	109.04
20	413.90	117.31
21	431.88	126.05
22	449.63	135.28
23	467.12	144.97
24	484.35	155.13
25	501.31	165.74
26	517.97	176.80
27	534.33	188.30
28	550.39	200.23
29	566.12	212.58
30	581.51	225.35
31	596.56	238.52
32	611.25	252.09
33	625.58	266.05
34	639.52	280.38
35	653.09	295.08
36	666.25	310.14
37	679.01	325.54
38	691.36	341.27
39	703.28	357.33
40	707.97	364.00

*** 1.380 ***

FAILURE SURFACE SPECIFIED BY 39 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	133.33	53.33
2	152.31	47.03
3	171.55	41.57
4	191.02	36.98
5	210.67	33.25
6	230.47	30.41

[illegible]	[illegible]	[illegible]
9	290.34	27.18
10	310.33	27.89
11	330.26	29.48
12	350.11	31.96
13	369.83	35.31
14	389.37	39.55
15	408.71	44.64
16	427.81	50.59
17	446.62	57.39
18	465.11	65.01
19	483.24	73.45
20	500.98	82.69
21	518.29	92.71
22	535.14	103.49
23	551.49	115.00
24	567.31	127.24
25	582.57	140.16
26	597.25	153.75
27	611.30	167.98
28	624.71	182.82
29	637.44	198.24
30	649.48	214.22
31	660.79	230.71
32	671.36	247.69
33	681.16	265.12
34	690.18	282.97
35	698.39	301.21
36	705.79	319.79
37	712.35	338.69
38	718.06	357.85
39	719.60	364.00

*** 1.383 ***

FAILURE SURFACE SPECIFIED BY 36 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	177.78	62.87
2	197.24	58.26
3	216.89	54.52
4	236.68	51.66
5	256.58	49.68
6	276.55	48.58
7	296.55	48.37
8	316.54	49.05
9	336.48	50.61
10	356.33	53.06
11	376.05	56.38
12	395.61	60.58
13	414.96	65.64
14	434.06	71.55
15	452.89	78.30
16	471.39	85.88
17	489.55	94.28
18	507.31	103.47
19	524.65	113.44
20	541.53	124.17
21	557.91	135.64
22	573.77	147.83
23	589.08	160.70
24	603.79	174.24
25	617.90	188.42
26	631.36	203.22
27	644.15	218.59
28	656.25	234.52
29	667.62	250.97
30	678.26	267.90
31	688.14	285.29
32	697.23	303.11
33	705.53	321.30
34	713.01	339.85
35	719.66	358.71
36	721.26	364.00

*** 1.389 ***

FAILURE SURFACE SPECIFIED BY 42 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	88.89	49.52
2	106.75	40.52
3	125.01	32.38
4	143.65	25.12
5	162.61	18.76
6	181.86	13.32
7	201.34	8.80
8	221.02	5.22
9	240.84	2.58
10	260.77	.90

12	300.76	.40
13	320.72	1.59
14	340.61	3.73
15	360.37	6.81
16	379.96	10.84
17	399.33	15.81
18	418.45	21.69
19	437.26	28.48
20	455.73	36.16
21	473.80	44.72
22	491.45	54.13
23	508.63	64.38
24	525.29	75.44
25	541.41	87.28
26	556.94	99.87
27	571.86	113.20
28	586.12	127.22
29	599.69	141.92
30	612.54	157.24
31	624.65	173.16
32	635.98	189.64
33	646.50	206.64
34	656.21	224.13
35	665.06	242.07
36	673.05	260.40
37	680.15	279.10
38	686.35	298.11
39	691.63	317.40
40	695.98	336.92
41	699.40	356.63
42	700.32	364.00

*** 1.402 ***

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                  Y             A      X      I      S             F      T


                   .00     232.50     465.00     697.50     930.00    1162.50

   X         .00 +-*-------+---------+---------+---------+---------+
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                 - ...8*6211..   *
                 - .....882215
                 -  ......862111
   X      697.50 +  .......863211
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   I      930.00 +
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   S     1162.50 +         *
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   F     1627.50 +
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   T     1860.00 +                *
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SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 14:28: 33

PROBLEM DESCRIPTION WASTE ROCK DUMP STABILITY ANALYSIS - SECTION NO. 2

BOUNDARY COORDINATES

6 TOP BOUNDARIES
12 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	50.00	85.00	57.00	2
2	85.00	57.00	200.00	65.00	2
3	200.00	65.00	330.00	73.80	2
4	330.00	73.80	463.60	175.00	1
5	463.60	175.00	740.00	175.00	1
6	740.00	175.00	800.00	187.00	1
7	330.00	73.80	350.00	75.00	2
8	350.00	75.00	390.00	95.00	2
9	390.00	95.00	424.00	105.00	2
10	424.00	105.00	460.00	135.00	2
11	460.00	135.00	660.00	155.00	2
12	660.00	155.00	740.00	175.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING SLIDING BLOCK SURFACES, HAS BEEN SPECIFIED.

50 TRIAL SURFACES HAVE BEEN GENERATED.

3 BOXES SPECIFIED FOR GENERATION OF CENTRAL BLOCK BASE

LENGTH OF LINE SEGMENTS FOR ACTIVE AND PASSIVE PORTIONS OF SLIDING BLOCK IS 30.0

BOX NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	WIDTH (FT)
1	330.00	73.80	330.00	73.80	.00
2	350.00	75.00	390.00	95.00	4.00
3	463.90	175.00	463.90	175.00	.00

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	353.82	78.77
3	463.90	175.00

*** 1.048 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	362.06	82.98
3	463.90	175.00

*** 1.049 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	362.45	82.93
3	463.90	175.00

*** 1.051 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	363.78	83.57
3	463.90	175.00

*** 1.051 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	360.85	81.92
3	463.90	175.00

*** 1.052 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	362.98	83.07
3	463.90	175.00

*** 1.052 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	353.13	77.85
3	463.90	175.00

*** 1.054 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	356.98	79.59
3	463.90	175.00

*** 1.055 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

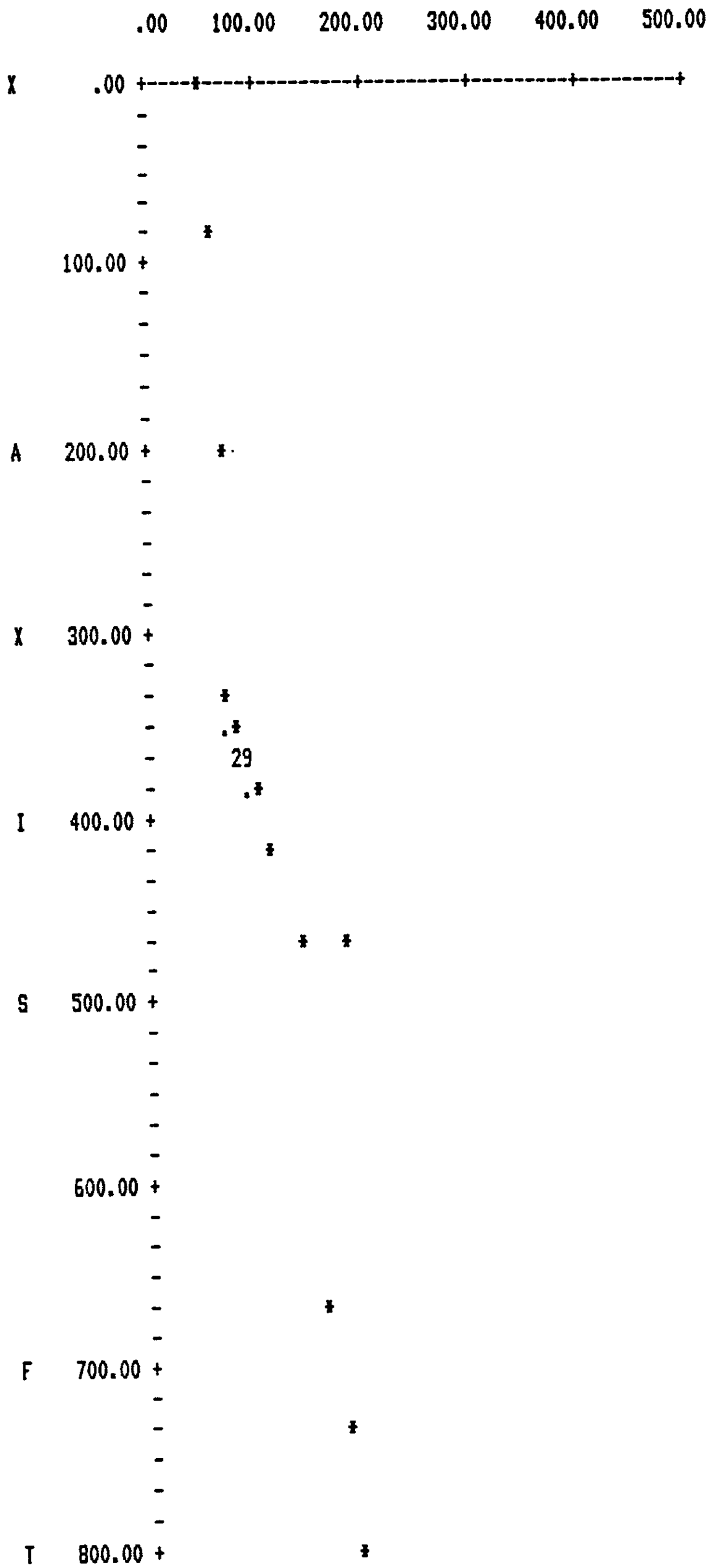
POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	368.15	85.45
3	463.90	175.00

*** 1.056 ***

FAILURE SURFACE SPECIFIED BY 3 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	330.00	73.80
2	358.17	80.04
3	463.90	175.00

*** 1.056 ***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29

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 14:29: 02

PROBLEM DESCRIPTION WASTE ROCK DUMP STABILITY ANALYSIS - SECTION NO. 2

BOUNDARY COORDINATES

6 TOP BOUNDARIES
12 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	50.00	85.00	57.00	2
2	85.00	57.00	200.00	65.00	2
3	200.00	65.00	330.00	73.80	2
4	330.00	73.80	463.60	175.00	1
5	463.60	175.00	740.00	175.00	1
6	740.00	175.00	800.00	187.00	1
7	330.00	73.80	350.00	75.00	2
8	350.00	75.00	390.00	95.00	2
9	390.00	95.00	424.00	105.00	2
10	424.00	105.00	460.00	135.00	2
11	460.00	135.00	660.00	155.00	2
12	660.00	155.00	740.00	175.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 300.00 FT.
AND X = 360.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 450.00 FT.
AND X = 550.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 30.00 FT.

10.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND 5.0 DEG.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	360.00	96.52
2	369.99	96.20
3	379.98	96.70
4	389.90	98.01
5	399.67	100.12
6	409.24	103.02
7	418.54	106.70
8	427.51	111.12
9	436.09	116.26
10	444.22	122.08
11	451.85	128.54
12	458.93	135.61
13	465.40	143.23
14	471.23	151.35
15	476.38	159.92
16	480.82	168.89
17	483.24	175.00

*** 1.272 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	360.00	96.52
2	369.93	95.36
3	379.93	95.19
4	389.90	96.02
5	399.73	97.83
6	409.34	100.61
7	418.62	104.34
8	427.48	108.97
9	435.84	114.45
10	443.61	120.75
11	450.72	127.78
12	457.09	135.49
13	462.67	143.79
14	467.39	152.61
15	471.21	161.85
16	474.09	171.42
17	474.79	175.00

*** 1.381 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	340.00	81.37
2	349.98	80.79
3	359.98	81.11
4	369.90	82.34
5	379.67	84.47
6	389.21	87.48
7	398.43	91.34
8	407.27	96.02
9	415.64	101.49
10	423.48	107.69
11	430.73	114.59
12	437.32	122.11
13	443.19	130.20
14	448.31	138.79
15	452.63	147.81
16	456.10	157.19
17	458.71	166.84
18	459.61	171.98

*** 1.424 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	360.00	96.52
2	369.98	97.20
3	379.90	98.43
4	389.74	100.20
5	399.47	102.50
6	409.06	105.34
7	418.48	108.70
8	427.70	112.57
9	436.70	116.94
10	445.44	121.80
11	453.90	127.13
12	462.06	132.91
13	469.88	139.14
14	477.35	145.78
15	484.45	152.83
16	491.15	160.26
17	497.43	168.04
18	502.44	175.00

*** 1.483 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	333.33	76.32
2	343.29	75.36
3	353.29	75.18
4	363.27	75.77
5	373.17	77.14
6	382.94	79.27
7	392.52	82.16
8	401.84	85.78
9	410.85	90.12
10	419.49	95.15
11	427.72	100.84
12	435.48	107.15
13	442.72	114.04
14	449.41	121.47
15	455.49	129.41
16	460.94	137.79
17	465.73	146.57
18	469.81	155.70
19	473.17	165.12
20	475.79	174.77
21	475.83	175.00

***   1.542 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	333.33	76.32
2	343.29	75.37
3	353.29	75.18
4	363.27	75.78
5	373.17	77.14
6	382.95	79.27
7	392.52	82.15
8	401.85	85.76
9	410.86	90.09
10	419.52	95.10
11	427.75	100.77
12	435.53	107.06
13	442.79	113.93
14	449.50	121.35
15	455.62	129.26
16	461.10	137.62
17	465.91	146.39
18	470.04	155.50
19	473.44	164.90
20	476.11	174.54
21	476.20	175.00

***   1.543 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	333.33	76.32
2	343.32	75.90
3	353.32	76.13
4	363.28	77.02
5	373.16	78.55
6	382.93	80.72
7	392.52	83.53
8	401.92	86.96
9	411.07	90.99
10	419.94	95.61
11	428.48	100.80
12	436.67	106.54
13	444.47	112.81
14	451.84	119.56
15	458.75	126.79
16	465.18	134.45
17	471.09	142.51
18	476.47	150.95
19	481.28	159.71
20	485.51	168.77
21	487.93	175.00

*** 1.553 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	326.67	73.57
2	336.64	72.79
3	346.64	72.85
4	356.60	73.75
5	366.44	75.48
6	376.11	78.04
7	385.53	81.41
8	394.63	85.56
9	403.34	90.46
10	411.62	96.07
11	419.39	102.37
12	426.60	109.30
13	433.20	116.81
14	439.15	124.85
15	444.40	133.36
16	448.91	142.28
17	452.65	151.56
18	455.60	161.11
19	457.64	170.49

*** 1.569 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	346.67	86.42
2	356.55	84.92
3	366.53	84.25
4	376.53	84.43
5	386.48	85.45
6	396.30	87.30
7	405.94	89.97
8	415.32	93.45
9	424.37	97.71
10	433.02	102.71
11	441.23	108.42
12	448.93	114.81
13	456.06	121.82
14	462.57	129.40
15	468.43	137.51
16	473.58	146.08
17	477.98	155.06
18	481.62	164.38
19	484.46	173.96
20	484.67	175.00

***   1.591 ***

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	340.00	81.37
2	349.62	78.66
3	359.46	76.86
4	369.42	75.99
5	379.42	76.06
6	389.37	77.08
7	399.18	79.02
8	408.76	81.88
9	418.03	85.62
10	426.91	90.23
11	435.32	95.64
12	443.18	101.83
13	450.42	108.72
14	456.98	116.27
15	462.81	124.40
16	467.84	133.04
17	472.04	142.11
18	475.36	151.54
19	477.79	161.24
20	479.29	171.13
21	479.51	175.00

***   1.629 ***

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              Y         A    X    I    S          F    T

                 .00   100.00   200.00   300.00   400.00   500.00

X        .00 +----*----+---------+---------+---------+---------+
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      100.00 +
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A     200.00 +      *
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X     300.00 +      .
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             -    ..*3
             -   ...8*9
             -   ....3.1
             -   ....33*
I     400.00 +  .....531
             -  .....051*
             -   .....0511
             -   ......05112338
             -   ........04*122*
             -    ..........4111
S     500.00 +     ...........44
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      600.00 +
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             -               *
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F     700.00 +
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             -                 *
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T     800.00 +                  *
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2

2

Break in 86

0

MOVE THE CURSOR TO THE POSITION FOR S.F. PLOT <RETURN> TO PLOT

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 14:39: 09

PROBLEM DESCRIPTION WASTE ROCK DUMP STABILITY ANALYSIS - SECTION NO. 3

BOUNDARY COORDINATES

3 TOP BOUNDARIES
18 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	50.00	190.00	50.00	2
2	190.00	50.00	586.00	350.00	1
3	586.00	350.00	1690.00	350.00	1
4	190.00	50.00	280.00	70.00	2
5	280.00	70.00	340.00	90.00	2
6	340.00	90.00	400.00	110.00	2
7	400.00	110.00	460.00	130.00	2
8	460.00	130.00	540.00	150.00	2
9	540.00	150.00	680.00	170.00	2
10	680.00	170.00	765.00	190.00	2
11	765.00	190.00	925.00	210.00	2
12	925.00	210.00	1070.00	230.00	2
13	1070.00	230.00	1215.00	250.00	2
14	1215.00	250.00	1350.00	270.00	2
15	1350.00	270.00	1495.00	290.00	2
16	1495.00	290.00	1550.00	310.00	2
17	1550.00	310.00	1600.00	330.00	2
18	1600.00	330.00	1690.00	350.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING SLIDING BLOCK SURFACES, HAS BEEN SPECIFIED.

50 TRIAL SURFACES HAVE BEEN GENERATED.

2 BOXES SPECIFIED FOR GENERATION OF CENTRAL BLOCK BASE

LENGTH OF LINE SEGMENTS FOR ACTIVE AND PASSIVE PORTIONS OF SLIDING BLOCK IS 25.0

BOX NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	WIDTH (FT)
1	190.00	50.00	190.00	50.00	.00
2	280.00	70.00	400.00	110.00	5.00

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 14 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	360.88	95.10
3	373.10	116.91
4	389.58	135.71
5	406.44	154.16
6	422.63	173.22
7	440.20	191.00
8	456.41	210.03
9	472.29	229.34
10	489.75	247.24
11	507.42	264.92
12	523.49	284.07
13	531.60	307.72
14	534.41	310.92

***   1.157 ***

FAILURE SURFACE SPECIFIED BY 11 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	394.66	110.01
3	411.51	128.48
4	428.95	146.39
5	444.27	166.14
6	456.27	188.07
7	469.78	209.11
8	483.80	229.81
9	498.40	250.10
10	506.28	273.83
11	512.62	294.41

***   1.192 ***

FAILURE SURFACE SPECIFIED BY 12 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	386.84	104.29
3	402.56	123.73
4	415.86	144.90
5	433.14	162.96
6	448.17	182.94
7	461.90	203.84
8	470.47	227.32
9	486.21	246.75
10	503.76	264.55
11	518.41	284.80
12	523.20	302.42

*** 1.194 ***

FAILURE SURFACE SPECIFIED BY 12 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	371.34	99.76
3	388.38	118.05
4	406.06	135.73
5	418.18	157.59
6	428.30	180.45
7	442.06	201.33
8	459.64	219.10
9	476.11	237.91
10	486.34	260.72
11	504.00	278.41
12	510.02	292.44

*** 1.198 ***

FAILURE SURFACE SPECIFIED BY 8 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	306.04	78.98
3	323.57	96.81
4	339.80	115.82
5	354.16	136.28
6	364.09	159.23
7	371.49	183.11
8	373.28	188.85

*** 1.227 ***

FAILURE SURFACE SPECIFIED BY 9 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	339.73	87.76
3	355.10	107.47
4	370.97	126.79
5	384.98	147.50
6	397.01	169.42
7	414.69	187.09
8	425.49	209.64
9	428.33	230.55

*** 1.228 ***

FAILURE SURFACE SPECIFIED BY 8 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	313.22	81.40
3	329.09	100.71
4	345.03	119.97
5	360.80	139.37
6	378.21	157.31
7	381.98	182.02
8	391.88	202.94

*** 1.238 ***

FAILURE SURFACE SPECIFIED BY 9 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	307.88	77.75
3	319.41	99.93
4	336.47	118.21
5	352.30	137.56
6	365.82	158.58
7	382.44	177.26
8	399.99	195.06
9	400.79	209.69

*** 1.243 ***

FAILURE SURFACE SPECIFIED BY 10 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	389.50	108.62
3	406.43	127.02
4	418.42	148.96
5	428.92	171.64
6	437.85	194.99
7	454.02	214.06
8	467.45	235.15
9	485.11	252.84
10	486.43	274.57

*** 1.259 ***

FAILURE SURFACE SPECIFIED BY 10 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	190.00	50.00
2	371.08	101.36
3	388.49	119.30
4	400.44	141.26
5	417.64	159.40
6	430.35	180.93
7	435.20	205.45
8	452.41	223.58
9	455.94	248.33
10	457.16	252.39

*** 1.270 ***

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              Y            A     X     I     S           F     T

                 .00   211.25   422.50   633.75   845.00  1056.25

 X        .00 +-*-------+---------+---------+---------+---------+
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       211.25 +
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 A     422.50 +     211466
              -     * 21110.
              -          2114
              -     *      121
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              -                *
 X     633.75 +
              -       *
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 I     845.00 +
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              -          *
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 S    1056.25 +           *
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              -             *
      1267.50 +
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 F    1478.75 +                *
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              -                 *
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 T    1690.00 +                   *
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--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 14:40: 17

PROBLEM DESCRIPTION WASTE ROCK DUMP STABILITY ANALYSIS - SECTION NO. 3

BOUNDARY COORDINATES

3 TOP BOUNDARIES
18 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	50.00	190.00	50.00	2
2	190.00	50.00	586.00	350.00	1
3	586.00	350.00	1690.00	350.00	1
4	190.00	50.00	280.00	70.00	2
5	280.00	70.00	340.00	90.00	2
6	340.00	90.00	400.00	110.00	2
7	400.00	110.00	460.00	130.00	2
8	460.00	130.00	540.00	150.00	2
9	540.00	150.00	680.00	170.00	2
10	680.00	170.00	765.00	190.00	2
11	765.00	190.00	925.00	210.00	2
12	925.00	210.00	1070.00	230.00	2
13	1070.00	230.00	1215.00	250.00	2
14	1215.00	250.00	1350.00	270.00	2
15	1350.00	270.00	1495.00	290.00	2
16	1495.00	290.00	1550.00	310.00	2
17	1550.00	310.00	1600.00	330.00	2
18	1600.00	330.00	1690.00	350.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 185.00 FT.
AND X = 350.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 600.00 FT.
AND X = 800.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 30.00 FT.

25.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND 5.0 DEG.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	203.33	60.10
2	228.31	61.24
3	253.18	63.78
4	277.87	67.72
5	302.29	73.04
6	326.38	79.73
7	350.05	87.77
8	373.24	97.12
9	395.86	107.77
10	417.84	119.68
11	439.12	132.80
12	459.62	147.10
13	479.29	162.54
14	498.06	179.05
15	515.86	196.60
16	532.65	215.13
17	548.37	234.57
18	562.97	254.86
19	576.40	275.94
20	588.63	297.75
21	599.61	320.21
22	609.30	343.26
23	611.70	350.00

***   1.146 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	258.33	101.77
2	283.29	103.31
3	308.09	106.41
4	332.66	111.06
5	356.88	117.25
6	380.67	124.94
7	403.92	134.11
8	426.56	144.72
9	448.49	156.73
10	469.61	170.10
11	489.86	184.76
12	509.15	200.66
13	527.40	217.74
14	544.55	235.94
15	560.52	255.17
16	575.25	275.37

18	600.77	318.34
19	611.46	340.94
20	615.07	350.00

*** 1.152 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	185.00	50.00
2	209.98	48.93
3	234.97	49.35
4	259.90	51.24
5	284.67	54.61
6	309.20	59.45
7	333.40	65.72
8	357.19	73.43
9	380.47	82.52
10	403.18	92.98
11	425.22	104.77
12	446.53	117.85
13	467.03	132.16
14	486.64	147.67
15	505.30	164.31
16	522.93	182.03
17	539.49	200.76
18	554.91	220.44
19	569.14	240.99
20	582.12	262.36
21	593.81	284.46
22	604.17	307.21
23	613.16	330.53
24	619.37	350.00

*** 1.171 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	295.00	129.55
2	319.99	130.35
3	344.85	132.99
4	369.44	137.47
5	393.64	143.74
6	417.31	151.78
7	440.33	161.55
8	462.56	172.99
9	483.88	186.03
10	504.19	200.62
11	523.36	216.66
12	541.30	234.08
13	557.90	252.77
14	573.08	272.63
15	586.76	293.56
16	598.85	315.44
17	609.29	338.15
18	613.71	350.00

*** 1.172 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	276.67	115.66
2	301.60	117.50
3	326.37	120.85
4	350.90	125.71
5	375.08	132.04
6	398.84	139.83
7	422.07	149.05
8	444.71	159.67
9	466.66	171.64
10	487.84	184.92
11	508.17	199.46
12	527.58	215.22
13	546.00	232.12
14	563.36	250.11
15	579.60	269.12
16	594.64	289.08
17	608.45	309.93
18	620.97	331.57
19	630.19	350.00

*** 1.181 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	350.00	171.21
2	375.00	171.14
3	399.88	173.57
4	424.39	178.50
5	448.28	185.85
6	471.32	195.57
7	493.26	207.56
8	513.89	221.68
9	532.99	237.81
10	550.38	255.77
11	565.88	275.39
12	579.33	296.46
13	590.59	318.78
14	599.56	342.11
15	601.71	350.00

*** 1.182 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	203.33	60.10
2	228.15	57.09
3	253.12	55.80
4	278.11	56.23
5	303.02	58.38
6	327.72	62.24
7	352.10	67.80
8	376.03	75.02
9	399.41	83.88
10	422.12	94.32
11	444.06	106.31
12	465.12	119.78
13	485.21	134.67
14	504.22	150.90
15	522.06	168.41
16	538.66	187.11
17	553.93	206.90
18	567.80	227.70
19	580.20	249.41
20	591.07	271.92
21	600.37	295.13
22	608.05	318.92
23	614.07	343.18
24	615.27	350.00

*** 1.185 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	203.33	60.10
2	228.14	56.96
3	253.09	55.51
4	278.09	55.75
5	303.02	57.68
6	327.75	61.29
7	352.19	66.57
8	376.21	73.49
9	399.71	82.02
10	422.58	92.13
11	444.71	103.75
12	466.01	116.85
13	486.37	131.36
14	505.69	147.22
15	523.91	164.34
16	540.92	182.66
17	556.65	202.09
18	571.03	222.54
19	584.00	243.92
20	595.48	266.12
21	605.44	289.05
22	613.83	312.60

24	623.39	350.00

*** 1.194 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	203.33	60.10
2	228.31	61.22
3	253.20	63.56
4	277.94	67.12
5	302.48	71.90
6	326.76	77.88
7	350.71	85.04
8	374.28	93.38
9	397.41	102.86
10	420.05	113.47
11	442.14	125.18
12	463.62	137.96
13	484.45	151.78
14	504.58	166.61
15	523.95	182.41
16	542.53	199.15
17	560.25	216.78
18	577.09	235.25
19	593.00	254.54
20	607.94	274.58
21	621.88	295.34
22	634.78	316.75
23	646.61	338.77
24	651.95	350.00

***   1.197 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	203.33	60.10
2	228.29	58.62
3	253.29	58.63
4	278.25	60.12
5	303.07	63.08
6	327.67	67.51
7	351.97	73.39
8	375.88	80.69
9	399.31	89.41
10	422.19	99.49
11	444.43	110.91
12	465.95	123.64
13	486.68	137.61
14	506.54	152.79
15	525.47	169.12
16	543.40	186.54
17	560.27	204.99
18	576.01	224.41
19	590.58	244.73
20	603.91	265.88
21	615.97	287.78
22	626.71	310.35

***   1.197 ***

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                          A     X     I     S           F     T

                 .00   211.25   422.50   633.75   845.00  1056.25
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                 -..3*.246
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      A   422.50 +...73126
                 - ...7*126
                 - ....73126
                 - .....*7112
                 - .........31116
                 -  .........33111*
      X   633.75 +   ..........9953
                 -    ...*........9
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      I   845.00 +
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      S  1056.25 +         *
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         1267.50 +
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      F  1478.75 +            *
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      T  1690.00 +               *
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--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

RUN DATE : 01/20/ 88 TIME : 14:44: 55

PROBLEM DESCRIPTION   WASTE ROCK DUMP STABILITY ANALYSIS - SECTION NO. 3

BOUNDARY COORDINATES

3 TOP   BOUNDARIES
18 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	.00	50.00	190.00	50.00	2
2	190.00	50.00	586.00	350.00	1
3	586.00	350.00	1690.00	350.00	1
4	190.00	50.00	280.00	70.00	2
5	280.00	70.00	340.00	90.00	2
6	340.00	90.00	400.00	110.00	2
7	400.00	110.00	460.00	130.00	2
8	460.00	130.00	540.00	150.00	2
9	540.00	150.00	680.00	170.00	2
10	680.00	170.00	765.00	190.00	2
11	765.00	190.00	925.00	210.00	2
12	925.00	210.00	1070.00	230.00	2
13	1070.00	230.00	1215.00	250.00	2
14	1215.00	250.00	1350.00	270.00	2
15	1350.00	270.00	1495.00	290.00	2
16	1495.00	290.00	1550.00	310.00	2
17	1550.00	310.00	1600.00	330.00	2
18	1600.00	330.00	1690.00	350.00	2

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	130.0	130.0	.0	37.0	.00	.0	1
2	125.0	125.0	1500.0	29.0	.00	.0	1

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

100 TRIAL SURFACES HAVE BEEN GENERATED.

10 SURFACES INITIATE FROM EACH OF 10 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 185.00 FT.
AND X = 225.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 600.00 FT.
AND X = 800.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 30.00 FT.

25.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

RESTRICTIONS HAVE BEEN IMPOSED UPON THE ANGLE OF INITIATION.
THE ANGLE HAS BEEN RESTRICTED BETWEEN THE ANGLES OF -45.0 AND 5.0 DEG.

... THE TEN MOST CRITICAL OF THE TRIAL
FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL
FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	216.11	69.78
2	241.10	70.35
3	266.02	72.37
4	290.78	75.82
5	315.30	80.70
6	339.50	86.99
7	363.29	94.67
8	386.60	103.71
9	409.34	114.09
10	431.45	125.77
11	452.84	138.71
12	473.45	152.86
13	493.20	168.18
14	512.04	184.62
15	529.89	202.12
16	546.70	220.62
17	562.41	240.07
18	576.97	260.39
19	590.33	281.53
20	602.44	303.39
21	613.27	325.93
22	622.77	349.05
23	623.10	350.00

***   1.164 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	202.78	59.68
2	227.74	61.09
3	252.59	63.76
4	277.28	67.70
5	301.74	72.88
6	325.90	79.30
7	349.71	86.94
8	373.09	95.78
9	396.00	105.80
10	418.36	116.97
11	440.13	129.26
12	461.25	142.64
13	481.66	157.08
14	501.31	172.53
15	520.15	188.97
16	538.12	206.34

18	571.32	243.71
19	586.45	263.61
20	600.55	284.26
21	613.58	305.59
22	625.51	327.56
23	636.26	350.00

*** 1.172 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	220.56	73.15
2	245.55	73.57
3	270.48	75.44
4	295.27	78.73
5	319.82	83.43
6	344.06	89.55
7	367.91	97.04
8	391.29	105.89
9	414.12	116.07
10	436.34	127.54
11	457.85	140.28
12	478.60	154.22
13	498.51	169.34
14	517.52	185.57
15	535.57	202.87
16	552.60	221.18
17	568.54	240.43
18	583.35	260.57
19	596.98	281.53
20	609.39	303.24
21	620.53	325.62
22	630.36	348.60
23	630.86	350.00

*** 1.180 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	193.89	52.95
2	218.64	49.44
3	243.58	47.69
4	268.58	47.70
5	293.52	49.48
6	318.27	53.00
7	342.71	58.26
8	366.72	65.24
9	390.17	73.88
10	412.96	84.16
11	434.97	96.02
12	456.09	109.40
13	476.21	124.24
14	495.24	140.45
15	513.07	157.97
16	529.63	176.70
17	544.82	196.56
18	558.58	217.43
19	570.84	239.22
20	581.52	261.82
21	590.59	285.12
22	597.99	309.00
23	603.69	333.34

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	198.33	56.31
2	223.28	54.70
3	248.28	54.53
4	273.25	55.80
5	298.10	58.50
6	322.76	62.63
7	347.14	68.17
8	371.15	75.11
9	394.73	83.42
10	417.79	93.07
11	440.26	104.04
12	462.06	116.28
13	483.11	129.76
14	503.36	144.43
15	522.73	160.24
16	541.15	177.13
17	558.57	195.06
18	574.93	213.97
19	590.17	233.78
20	604.25	254.44
21	617.11	275.88
22	628.72	298.02
23	639.03	320.80
24	648.02	344.13
25	649.90	350.00

***   1.207 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	220.56	73.15
2	245.49	74.98
3	270.30	78.01
4	294.94	82.25
5	319.34	87.68
6	343.45	94.29
7	367.21	102.07
8	390.57	110.99
9	413.46	121.03
10	435.84	132.18
11	457.65	144.40
12	478.84	157.66
13	499.36	171.94
14	519.16	187.20
15	538.20	203.41
16	556.43	220.52
17	573.80	238.49
18	590.28	257.29
19	605.83	276.87
20	620.41	297.18
21	633.98	318.18

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	193.89	52.95
2	218.48	48.46
3	243.33	45.68
4	268.31	44.61
5	293.30	45.25
6	318.19	47.61
7	342.85	51.68
8	367.18	57.43
9	391.06	64.83
10	414.37	73.86
11	437.01	84.46
12	458.87	96.60
13	479.84	110.21
14	499.83	125.22
15	518.74	141.57
16	536.49	159.18
17	552.98	177.97
18	568.14	197.85
19	581.90	218.72
20	594.20	240.49
21	604.97	263.05
22	614.17	286.29
23	621.75	310.12
24	627.68	334.40
25	630.37	350.00

*** 1.215 ***

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	202.78	59.68
2	227.61	56.78
3	252.57	55.43
4	277.57	55.64
5	302.51	57.41
6	327.29	60.72
7	351.81	65.57
8	375.99	71.94
9	399.72	79.79
10	422.92	89.12
11	445.49	99.86
12	467.35	111.99
13	488.41	125.46
14	508.59	140.22
15	527.82	156.20
16	546.01	173.35
17	563.10	191.59
18	579.02	210.87
19	593.71	231.10
20	607.11	252.20
21	619.18	274.10

24	646.89	343.69
25	648.53	350.00

*** 1.218 ***

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	189.44	50.00
2	213.76	44.21
3	238.45	40.26
4	263.36	38.18
5	288.36	37.99
6	313.31	39.68
7	338.05	43.24
8	362.46	48.66
9	386.39	55.90
10	409.70	64.92
11	432.27	75.67
12	453.97	88.08
13	474.67	102.10
14	494.26	117.64
15	512.62	134.60
16	529.65	152.91
17	545.25	172.44
18	559.34	193.09
19	571.84	214.74
20	582.67	237.28
21	591.77	260.56
22	599.09	284.47
23	604.59	308.85
24	608.24	333.58
25	609.41	350.00

*** 1.222 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	211.67	66.41
2	236.66	67.10
3	261.59	68.97
4	286.40	72.03
5	311.04	76.27
6	335.44	81.68
7	359.57	88.25
8	383.35	95.96
9	406.73	104.80
10	429.67	114.75
11	452.11	125.77
12	473.99	137.86
13	495.28	150.97
14	515.91	165.08
15	535.85	180.17
16	555.04	196.18
17	573.45	213.10
18	591.04	230.87
19	607.75	249.46
20	623.56	268.83
21	638.42	288.93

[illegible]	[illegible].20	331.14
24	675.35	350.00

*** 1.240 ***

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              Y          A     X     I     S          F     T

                   .00    211.25   422.50   633.75   845.00  1056.25

  X       .00 +-*-------+---------+---------+---------+---------+
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                -
                -
                -
                - *
       211.25 + 41.
                - 416
                -.4*1
                -.721
                -.74*3
                -..45*
  A    422.50 + .7411
                - ..94*1
                - ...7421
                - ....9*411
                -  .....75111
                -   ......7521114*
  X    633.75 +    ........55321
                -    ..*......006
                -     ...........
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                -      *  ......
                -             ..
  I    845.00 +
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  S   1056.25 +           *
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      1267.50 +
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  F   1478.75 +             *
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  T   1690.00 +                *
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This page is a reference page used to track documents internally for the Division of Oil, Gas and Mining

Mine Permit Number M0350009 Mine Name Barneys Canyon Mine
Operator Kennecott Barneys Cyn Date January 21, 1988
TO ______________ FROM ______________

__CONFIDENTIAL __BOND CLOSURE __LARGE MAPS X EXPANDABLE
__MULTIPUL DOCUMENT TRACKING SHEET __NEW APPROVED NOI
__AMENDMENT _OTHER______________

Description YEAR-Record Number

__NOI ✓ Incoming __Outgoing __Internal __Superceded

Geotecnical Investigation Report

__NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

__TEXT/ 81/2 X 11 MAP PAGES __11 X 17 MAPS __LARGE MAP

COMMENTS: ______________

CC: ______________